THE CANADIAN PETROLEUM ASSOCIATION

Petroleum Industry Waste Management Study

Phase III: Priority Waste Characterization

June 1989

Prepared for:
Waste Management Subcommittee
Environmental Planning and Management Committee

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SECTION 1.0

THE STUDY

1.0 THE STUDY

1.1 Introduction

This report represents Phase III of a set of projects conducted by the Canadian Petroleum Association's (CPA) Environmental Planning and Management Committee. The Committee established a Waste Management Subcommittee in early 1988 to identify strategies for petroleum industry waste management. The Waste Management Subcommittee's strategy has consisted of:

- -Phase I: A CPA membership survey identified the various disposal methods and associated problems encountered with 85 different wastes from the production side of the industry. The survey results are contained in the report "The Canadian Petroleum Association, Industry Waste Survey, September 1988".

- -Phase II: An estimation of industry waste volumes and waste characterization data which was available for the 85 wastes types. Results are contained in the report "Petroleum Industry Waste Management Study, Phase II: Inventory, Characterization, March 1989."

- -Phase III: This report is a further investigation of available characterization data of 26 priority wastes identified in Phase II. A list of ongoing petroleum waste research projects and literature references are also presented.

The results from Phases I, II, & III will be used to develop Waste Management Guidlelines for petroleum production operations (Phase IV).

The following 26 wastes were identified in Phase II as requiring further research to investigate the extent of waste characterization data available from the petroleum industry and related bodies.

Filters: DEA Amine
MEA Amine
DIPA Amine X
Glycol
Lube Oil (Hydrocarbon)
Lube Oil (Synthetic) X
Sulphinol
Process Water
Produced Water
Raw Water
Water Injection X

Other: Produced Sand
Hydrocarbon Removal Waste X
Process Waste Water
Wash Fluids, Solvent X
Wash Fluids, Water X
Well Workover Acid Waters
Well Workover Hydrocarbons

Sludges: Gas Sweetening
Sulphur Block Runoff Pond
Process Pond
Flare Knockout
Flare Pit
Treater Bottoms
Tank Bottoms
Neutralization

These wastes were classified as priority wastes for the following reasons:

- -A significant volume of the waste may be generated.
- -The wastes have been previously classified as hazardous when only limited characterization data was available.
- -The large differences in disposal costs between classes of landfills gives an economic incentive to confirm the wastes' classification.
- -Regulatory agencies may not be supportive of existing and proposed disposal methods.

A further description of the rational for priority waste classification is contained in Section 1.5 of the Phase II report. No additional waste characterization data was available for wastes marked with an "X" on the previous page.

1.2 The Study Method

Information on the priority wastes' characterizations were obtained from the following sources:

- -An on-line literature search of published information which revealed over 900 articles on petroleum wastes, oil field and refinery sludges, filters and other associated wastes. 65 articles were ordered of which 25 contained useful information. The majority of articles were from the United States, however, related information was also obtained from Germany, Japan, and the Soviet Union.

- -Waste analysis and related information was received from 25 field locations, 8 corporate offices, 6 independent laboratories, 6 waste broker/disposal companies and the provincial governments.

- -Communication with the American Petroleum Institute's (API) Production Department and members of the API Production Waste Issue Group.

- -Communication with the U.S. Environmental Protection Agency (EPA) offices in Washington, D.C., the Cincinnati Research Laboratory, and EPA district offices in Seattle, Denver and Dallas.

- -Correspondence with The Oil Companies' European Organization for Environmental and Health Protection (CONCAWE).

The data from the above sources was extensively reviewed and summarized. The results are presented in Section 2.

1.3 Analytical Protocols

During this study, a review of the available analytical data clearly indicated that there are currently no standardized or widely accepted sampling and analytical protocols for petroleum industry wastes. This statement holds true for the analysis of organic compounds and to a lesser extent for inorganic and trace metal analysis.

The United States Environmental Protection Agency (EPA) has developed analytical methods for priority pollutants which are used as a basis for the analysis of most organic compounds. These EPA methods have been adapted and modified to identify and quantify a wide range of organics which may be present in petroleum wastes.

To undertake such an analytical program is not cost effective and will produce limited meaningful information to environmentalists on a specific waste's environmental impact.

Sampling Protocols

Very limited information was available during this study on sampling procedures and sample preservation techniques.

Further investigation via gas plants and oil producing facilities indicated that a wide variety of sample techniques are used. These range from surface sampling of ponds with various manual devices to sludge samples at specific pond depths.

Water sampling techniques ranged from time/flow co-ordinated composite samples to manual composition of grab samples to single grab samples. Some samples had been refrigerated while others were maintained at ambient temperature.

Filter samples ranged from the removal of surface deposits from the filter elements to coring a filter element. Some filters were analysed when taken out of service. In some cases, filters were drained of all excess fluids and in two cases, they were steam cleaned before analysis.

Analytical laboratories supplied what information they could and in most cases they have a step by step sampling program developed. However, the sample collection is usually outside the jurisdiction of the commercial laboratory.

Metals Analysis

Metals analysis methods are usually based on the availability of automated analytical equipment in the laboratory. Therefore, metals analysis have been reported by wet chemistry methods, IPAC/IC (Inductivity Coupled Argon Plasma) and AA (Atomic Absorption). the detection levels of metals by various procedures are well known to the laboratories and usually the correct methods have been selected. For instance, mercury and lead analysis are seldom carried out by ICAP. Other important criteria for method selection are the presence of metals at substantial concentrations in the waste, known contamination problems and compounds that may produce interferences.

The confusion in metals analysis (particularly trace metals) appear to centre around the different methods of sample preparation prior to analysis. Metals have been reported on acid digested samples, ashed and extracted samples and on various leachate samples. This means that the reported values may be "total metals" or may be "leachable" metals.

The newly amended Transportation of Dangerous Goods Regulations (TDGR) includes a leachate protocol for Class 9 substances (similar to the British Columbia Special Waste Legislation) and lists limits for 25 materials (Classification 9.3) Therefore, the standardization of sampling and sample preparation procedures is an important requirement. Metals Analysis, including trace metals, are better organized than organic analysis.

Organic Analysis

The identification and qualification of organic compounds are much more complicated and problematic than inorganics. The approachs used by the Japanese petroleum industry (Ref. 11), the Austrian and West German petroleum industry and by the EPA (Skinner List) are designed to identify target compounds only, specific to a type of petroleum operation. The analytical methodology is then organized around the target compounds to the extent they can be measured analysed and present in the particular waste material.

For characterization purposes it may be desirable to select fewer compounds, particularly if there are considerable cost savings with little or no loss of confidence in the ability to detect contaminants which effect the classification criteria of a given waste material. For example, most petroleum wastes contain high concentrations of aliphatic hydrocarbons. These constituents are of limited interest in assessing whether or not a waste is hazardous.

A number of target parameters have been proposed and developed. The most comprehensive of these lists is the 1984 report by Mr. John Skinner, Director, OSW "Guidance on Petroleum Waste Analysis."

Using the target approach, a generally accepted methodology could be developed and adapted by commercial and institutional laboratories. The critical step in developing such a methodology is to demonstrate that the methods will provide acceptable precision and accuracy for target compounds in the waste for which the method is designed. At a minimum, this method validation data should include recovery results and detection limits in a representative waste sample. To date, the only data found was by U.S. EPA consisting of a few compounds spiked into a few petroleum waste samples.

1.4 Waste Classification Summary

The following table represents a summary of the waste classification data which is presented in Section 2.0. The table offers a general overview of the indicated waste classifications and the range of analysis with respect to regulatory limits. The results should be viewed in consultation with the individual "Waste Information Sheets" and the waste sheet interpretation notes at the front of Section 2.0.

The columns in the table labelled "Range of Analysis" indicate whether all or a portion of the analysis were above or below the regulatory limits for the regulated component(s). The rationale for deciding which component(s) was used to define the hazardous classification is discribed in "Rationale for Classification" in section 6 of the Waste Information Sheet.

	Indicated Waste Classification (based on average concentration)		Range of Analysis (with respect to regulatory limits)			Data Reliability
Waste Type	Hazardous	Non-Hazardous	Above	Below	Both	
019 Filters - DEA Amine		X		X		C
021 Filters - MEA Amine	X				X	B
022 Filters - Glycol	X				X	D
023 Filters - Lube Oil (Hydrocarbon)	X				X	C
025 Filters - Process Water		X			X	B
026 Filters - Produced Water	X		X			C
027 Filters - Raw Water		X		X		B
028 Filters - Sulfinol	X				X	D
054 Process Waste Water	X				X	C
055 Produced Sand		X			X	B
059, 60, 61, 62 Sludges - Tank Bottoms	X				X	B
063, 64, 65, 75 Sludges - Gas Sweetening	X				X	C
031 Sludge - Flare Knockout	X				X	D
068 Sludge - Flare Pit	X				X	A
073 & 76 Sludge - Neutralization	X				X	C
074 Sludge - Process Pond (Evaporation Pond)	X				X	A
077 Sludge - Treater Bottom	X				X	B
083 Well Workover Fluids - Acid Water	X				X	E
084 Well Workover Fluids - Hydrocarbon	X				X	E

1.5 Recommendations

Analytical Protocols

As discussed in Section 1.3, there are currently no acceptable universal standards for analytical protocols. The published protocols such as "Standard Methods" or EPA procedures are used as starting points only. Most competent laboratories (whether institutional or commercial) have developed their own procedures that combine the standard methods, equipment suppliers' procedures and their own experience. Therefore, these procedures which include sample handling, analysis, data interpretation, quality assurance and quality control, are considered proprietary by many.

Lab analysis is usually done on a case by case basis with an effort to provide the most cost effective method. Subsequently, variations are constantly made to the methodology causing a non-uniform approach to the analysis. Sometimes this is merited, but usually it is because there are no clear guidelines.

In order to provide meaningful data and to commence an evaluation of the presently used methods, recovery and detection limits validation will be required. This should be undertaken with the participation of all commercial laboratories working for CPA member companies as well as laboratories operated by regulatory authorities.

The data generated could then be used as a basis to commence an overall evaluation of the effectiveness of methods as well as provide indication of areas requiring additional study.

Data Confidence Level

Each of the wastes have been assigned a confidence level on the waste information sheets. Any wastes with a confidence level D or E definitely require further attempts to obtain analytical data.

SECTION 2.0

PRIORITY WASTE CHARACTERIZATION ANALYSIS

2.0 PRIORITY WASTE CHARACTERIZATION ANALYSIS

This section contains information sheets on each of the priority wastes identified in Phase II and listed in Section 1.1. An explanation of the analysis information is given below.

Section 1: WASTE MATERIAL IDENTIFICATION

Identification Number: The waste number assigned in Phase I & II.

Waste Name: The waste names and synonyms as they are commonly known in the petroleum industry.

Chemical Name: The technical chemical name and possible synonyms of the major components in the waste. Includes only components that were identified in analysis received during the study. The technical chemical name was used to permit a comprehensive search of scientific literature and reference to the chemical Material Safety Data Sheets.

Date: The completion date of the information sheet based on analysis received up to that date.

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Section 2: WASTE MATERIAL SOURCE

Identifies where the waste is commonly generated in the petroleum industry.

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Section 3: SIGNIFICANT COMPONENTS AND AVERAGE CONCENTRATIONS

Possible chemical components which may be present in the waste are listed with the average concentration and range expressed in mg/kg or%. The ranges indicate the variance in the different sampling techniques that were used for the analyses received. This information may be useful in determining proper laboratory analysis for waste classification and manifesting. However, the information is very general, based only on the analysis received, and may not apply to all wastes of this type.

.....

Section 4: ANALYTICAL METHODS

A description of the analytical methods used in the sample analysis collected. Refer to Section 1.3 for further information.
Abbreviations:
AA - Atomic Absorption
GC/FID - Gas Chromatograph / Flame Ionization Detection
GC/MS - Gas Chromatograph / Mass Spectroscopy
HPLC - High Pressure Liquid Chromatography
ICAP - Inductively Coupled Argon Plasma
IR - Infrared
LC - Lethal Concentration
PAH - Polycylic Aromatic Hydrocarbons

Section 5: HEALTH HAZARDS AND SAFETY INFORMATION

Toxicology: The adverse health effects which may result from exposure to the waste's significant components either by the mouth (oral), skin (dermal), respiratory tract (inhalation) or eye.

Abbreviations: SEV - Severe, MOD - Moderate, CAR - Carcinogin

Physical and Chemical Hazards: Data which defines the potential for the significant components to aggressively react with other commonly found chemicals or to decompose thereby representing a special hazard.

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Section 6: INDICATED WASTE CLASSIFICATION

TDGR Number and Classification: The Transportation of Dangerous Goods (TDG) Product Identification Number (PIN) followed by the item number in brackets. The item number is the list number in Schedule II, List II of the Transportation of Dangerous Goods Regulations.

TDGR Classification: The primary shipping classification of the waste's significant component. If a definite class cannot be identified then the potential classifications are listed.

Hazardous Waste Classification: In this section, the waste is given a hazardous or a non-hazardous classification.

The classification is based on: 1) the components identified in the sample analysis that were received and 2) the definitions contained in the Alberta Hazardous Waste Regulations and the British Columbia Special Waste Regulations. Because of differences in the regulations, some wastes may be hazardous in B.C. and non-hazardous in Alberta. This is noted on the individual sheets.

When identified as non-hazardous, there is still potential for the waste to be hazardous when the significant components are above the identified range, or when other components, not included in the significant component listing are present. As a result, this information should be used only as a guideline and does not replace the analytical requirements contained in the regulations.

A number of petroleum production wastes are exempt from the Alberta Hazardous Waste Regulation under Section 2(f). This exemption was not taken into consideration during this preliminary classification. The hazardous or non-hazardous classification are based solely on the chemical characteristics of the individual wastes.

Rationale for Classification: Specific information on how the wastes were classified.

Section 7: REFERENCES

Analytical Data: Refers to the number of analysis reviewed which form the basis for the information presented on the Waste Information Sheets.

Toxicology: Published references used for defining the waste's toxicology.

Data Reliability: A confidence level rating system for the waste information presented on the Waste Information Sheets:

Level A: High confidence level. Minimum of six independent analysis available for review. Good correlation between analytical data.

Level B: Good confidence level. Minimum of six independent analysis available for review. Reduced level of correlation between analytical data. Reference standards are not available.

Level C: Medium confidence level. Three to five independent analysis available for review. Differences between analysis in excess of 30%. Reference standards are not available.

Level D: Low confidence level. Less than three independent analysis available for review or differences exceed 50%. Confirmation work is required.

Level E: Minimum confidence level. Single analytical data available for review. No reference standards are available. Further work is required.

CANADIAN PETROLEUM ASSOCIATION

WASTE INFORMATION SHEET

1. Waste Material Identification: Id. Number: 19

Waste Name: Filters - Diethanolamine (DEA) Date: June 8, 1989.
Synonyms:
Chemical Name of Major Components: Diethanolamine, Cyanide, Thiocyanate, Vanadium, Amine Degradation Products.
Chemical Synonyms: Di (2-hydroxyethyl) amine.

2. Waste Material Source

DEA is the most widely used alkanolamine solution sold for the removal of acid gases (CO_2, H_2S, COS and CS_2) from natural gas. It is estimated that 74 sour gas plants in Alberta, Saskatchewan and British Columbia use DEA. These filters are used for the removal of corrosion products, DEA decomposition products and other impurities from the recirculating solvent solution. Both rich amine and lean amine filters are included in this waste category.

3. Significant Components and Average Concentrations

Components	Average Concentration	Range
Inorganic Constituents		
Cyanide	72.5 mg/kg	7.5 to 200 mg/kg
Thiocyanate	6200 mg/kg	5.0 to 18,000 mg/kg
Sulfide	1200 mg/kg	225 to 4,360 mg/kg
Chloride	No data available.	
Vanadium	525 mg/kg	430 to 620 mg/kg
Trace Metals		
Arsenic	2.8 mg/kg	0.01 to 10.5 mg/kg
Cadmium	0.05 mg/kg	0.0004 to 0.1 mg/kg
Chromium (Cr^{+6})	2.95 mg/kg	0.032 to 8.7 mg/kg
Lead	33.8 mg/kg	0.001 to 40.0 mg/kg
Mercury	0.15 mg/kg	0.005 to 0.53 mg/kg
Nickel	17.2 mg/kg	0.02 to 50.0 mg/k
Thallium	0.21 mg/kg	0.03 to 0.37 mg/k
Selenium	No data available.	

Waste Name: **Filters - Diethanolamine (DEA) Cont'd**

Id. Number: **19**

Organic Constituents		
Residual DEA	2.1%	0.05% to 18%
TVO	1.0%	No range available.
Oil and Grease	3.25%	0.8% to 9.94%
Amine Degradation Products	0.03%	No range available.

Notes on Analytical Data:

Note 1: Only trace metals listed in the Alberta Hazardous Waste Regulations, and which may influence the disposal of this waste in a landfill, are reported.

Note 2: The wide range of constituents reported is the result of various cleaning procedures used on the filters (draining of free liquids, steaming, water washing) prior to analysis.

Note 3: Only limited analytical data was found for amine degradation products (2 analysis). Review of available literature indicate that the major degradation products of DEA are N,N,N-tris (2-hydroxyethyl) ethylenediamine (THEED) and N,N-bis(2-hydroxyethyl) piperazine (HEP) (Ref. Hadda et al. 1969., Meisen and Kennard 1982). Present data indicate that HEP concentrations in the range of 0.5% may occur.

4. Analytical Methods

1. All analysis were performed on both "as received" and drained and/or cleaned filter elements.

2. Trace metals analysis were carried out on acid digested samples by Inductively Coupled Argon Plasma spectrometer (ICAP). (Wet ash method is also acceptable). Mercury and lead analysis were carried out by flameless Atomic Absorption (AA) method.

3. Oil and grease content were determined by gravitimetric methods on freon extracted samples according to EPA Method 413.1 IR Relative Absorbance method. (EPA Method 413.2 measured at a 454 nm is also used). These results should be used with caution since the method is specific for certain chromophones and may give low results.

4. Four residual DEA samples were analysed by High Pressure Liquid Chromatography technique. The filter material is extracted with deionized water then centrifuged. The supernatant is derivatized and injected onto a PAH column of the HPLC equipped with a U/V detector. Both LC separation and solvent extraction methods may be used. No information is available regarding the DEA recovery efficiency of the extraction procedure.

5. Amine Degradation Product identifications were carried out by GC/FID and GC/MS in accordance with methods developed by Enviro-Test Laboratories.

5. Health Hazards and Safety Information

Toxicology (Significant Components):

Diethanolamine - This material has a slight to moderate toxic hazard rating as a skin irritant and for ingestion and inhalation.

Waste Name: **Filters - Diethanolamine (DEA) Cont'd**

Id. Number: **19**

Thiocyanate: Low acute toxicity. May product skin irritation and nausea upon prolonged exposure.

Vanadium: Toxicity variable depending on type of compound. Prolonged exposure may lead to lung irritation

Physical and Chemical Hazards:

Diethanolamine: Can react with oxidizing materials i.e. chlorine gas.

Thiocyanate: Dangerous when heated to decomposition or on contact with acid or acid fumes. May emit highly toxic fumes of cyanides.

Vanadium: No information is available. Variable depending on compound.

6. Indicated Waste Classification:

TDGR Number (if listed): N/A

TDGR Classification (if listed): 9.2 (Possibly)

Hazardous Classifications:

British Columbia:	Hazardous:	
	Non-hazardous:	X
Alberta:	Hazardous:	
	Non-hazardous:	X

Rationale for Classification: Based on the analytical data found, this waste does not appear to contain TDGR listed components in sufficent concentrations to warrant hazardous/special classification. However, it should be noted that a number of volatile organics and vanadium compounds are listed as Class 9.2 in the TDGR. Should these compounds be found at concentrations exceeding 100 mg/kg, the waste would then be classified as hazardous in Alberta and special in British Columbia. Additional analytical work would be required to confirm the existence of these compounds.

Leachate tests may make this Hazardous under Classification 9.3 (Limit for lead is 5.0 mg/l).

Waste Name: Filters - Diethanolamine (DEA) Cont'd

Id. Number: 19

7. References

Analytical Data:	11
Toxicology:	Sax, Sixth Edition
Analytical Methodology:	D.A.Birkholz, Enviro-Test Laboratories (1988) CPA Gas Plant Study - III.
	Carter, J.J. et al (1985) US EPA Symposium of Solid Waste Testing.
Data Reliability:	C

The information contained in this document is believed to be reliable as of the date of issue, but such information is nonetheless of a general nature. The user or those in contact with this waste must utilize the information supplied to develop appropriate safe work and handling practices. All statements and suggestions are made without warranty, express or implied, regarding the completeness or accuracy of the information, the hazards connected with the waste material itself or the results obtained from the handling, transportation or disposal of the material. In addition, the CPA and its consultant must rely upon the persons handling the waste material to exercise care and precautions integral to hazardous waste transportation/ disposal operations.

CANADIAN PETROLEUM ASSOCIATION

WASTE INFORMATION SHEET

1. **Waste Material Identification:** Id. Number: 21

Waste Name: Filters - Monoethanolamine (MEA) Date: May 25, 1989
Synonyms:
Chemical Name of Major Components: Monoethanolamine, Cyanide, Thiocyanate, Lead.

Chemical Synonyms: 2-Aminoethanol, Beta Aminoethyl Alcohol.

2. **Waste Material Source**

MEA is used in sour gas plants to remove CO_2, H_2S, COS and CS_2 from natural gas. These filters remove corrosion products, MEA decomposition products and other impurities. Both rich amine and lean amine filters are included in this waste category.

3. **Significant Components and Average Concentrations**

Components	Average Concentration	Range
Inorganic Constituents		
Cyanide	75 mg/kg	50 to 250 mg/kg
Thiocyanate	850 mg/kg	600 to 20,000 mg/kg
Sulfide	425 mg/kg	300 to 700 mg/kg
Chloride	0.5 mg/kg	Not Reported
Trace Metals		
Arsenic	< 25 ppb	< 25 ppb
Cadmium	1.8 mg/kg	0.15 to 2.5 mg/kg
Chromium (Cr^{+6})	5.0 mg/kg	0.4 to 6.3 mg/kg
Lead	225 mg/kg	183 to 445 mg/kg
Mercury	6.5 mg/kg	2.8 to 9.5 mg/kg
Nickel	30.0 mg/kg	0.45 to 62.0 mg/kg
Thallium	No data available	
Selenium	No data available	
Organic Constituents		
Residual Monoethanolamine (MEA)	3.3%	2 to 15%
Oil and Grease	0.2%	0.1 to 2.5%

Notes on Analytical Data:

Note 1: Only trace metals listed in the Alberta Hazardous Waste Regulations and, which may influence the disposal of this waste in a landfill, are reported.

Note 2: Residual MEA concentrations will depend on how well the filter is drained prior to the analysis.

Waste Name: Filters - Monoethanolamine (MEA) Cont'd

Id. Number: 21

4. Analytical Methods

All analysis were performed on the wet sludge removed from the surfaces of the filters and are reported on a wet weight basis.

Trace metals were determined (not including Hg and Pb) on either acid digested or sodium carbonate/sodium peroxide fused samples by Plasma Emission Spectroscopy (ICAP)/Inductively Coupled Plasma (ICP). Mercury and lead analysis were carried out by flameless Atomic Absorption (AA) method.

For residual MEA analysis both High Pressure Liquid Chromatography (HPLC) and Gas Chromatography (GC) were used. Procedures were, in general, based on USEPA Standard methods although extraction, sample preparation and quality control procedures, are specific to individual laboratories.

There is no information regarding the verification of the extraction procedures efficiency.

5. Health Hazards and Safety Information

Toxicology (Significant Components):

Monoethanolamine - Irritation Effects: Sev. eye, MOD skin, MOD via oral, dermal.

Thiocyanate - Low acute toxicity.

Physical and Chemical Hazards:

Thiocyanate - Violent reactions occur when mixed with chlorates, nitrates and organic peroxides. Dangerous when heated to decomp. or contact with acids. May emit highly toxic cyanide fumes.

Lead - Irritation effects: HIGH oral. Some compounds are CAR. Mode of entry by inhalation, ingestion, skin (Organic Lead Compounds).

6. Indicated Waste Classification:

TDGR Number (if listed): 2491 (Item No: 1268) MEA (if not drained)

TDGR Classification (if listed): 9.3 (Likely)

Hazardous Classifications:

British Columbia: Special Waste: X

Non-Special Waste:

Waste Name: **Filters - Monoethanolamine (MEA) Cont'd**

Id. Number: **21**

Alberta:	Hazardous:	X
	Non-hazardous:	

Rationale for Classification:

Undrained MEA filters could also be classified as hazardous/special since MEA is listed as a Class 8 dangerous good (TDGR No. 2491, Item No. 1268)

Although leachate extraction test results were not found, it is likely that the concentration of lead in leachates extracted from this waste will exceed 5.0 mg/L. As such, this waste will likely meet the criteria of Class 9.3 under the TDGR and will, therefore, be a hazardous waste in Alberta and a special waste in British Columbia.

In addition, since a number of lead compounds are listed as Class 9.2 in the TDGR, it is conceivable that this waste could be classified as hazardous or special if these compounds are present at concentrations exceeding 100 mg/kg.

7. References

Analytical Data:	6
Toxicology:	Sax, Sixth Edition
Analytical Methodology:	
Data Reliability:	B

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CANADIAN PETROLEUM ASSOCIATION

WASTE INFORMATION SHEET

1. **Waste Material Identification:** Id. Number: 22

Waste Name: Filters - Glycol Date: June 12, 1989.
Synonyms :
Chemical Name of Major Components:Glycols, (MEG, DEG, and TEG), Iron Sulphide, Carbon
Chemical Synonyms:Ethylene Glycol (Mono, Di and Tri).

2. **Waste Material Source**

Glycol is used as a liquid desiccant in the natural gas dehydration process. Triethylene glycol is the most common because it is less prone to vapour losses. These filters are used to remove corrosion products and other impurities from the glycol as it is recycled and regenerated in a closed system. Both sweet gas and sour gas plant may produce this waste.

3. **Significant Components and Average Concentrations**

Components	Average Concentration)	Range
Inorganic Constituents		
Iron Sulphide	1.3%	1.0% to 3.1%
Iron Oxide(s)	0.8%	0.5% to 2.5%
Boron	No data available	
Inorganic Residue (Ash)	10.6%	4.5% to 12.0%
Trace Metals		
Arsenic	0.2 mg/kg	0.15 to 0.35 mg/kg
Cadmium	2.35 mg/kg	0.34 to 4.36 mg/kg
Chromium (Cr^{+6})	23.5 mg/kg	0.9 to 50 mg/kg
Lead	350 mg/kg	<0.01 to 700 mg/kg
Mercury	0.2 mg/kg	<0.01 to 0.4 mg/kg
Nickel	24.8 mg/kg	1.96 to 50 mg/kg
Thallium	0.09 mg/kg	No range reported
Selenium	No data available	

Waste Name: **Filters - Glycol (Cont'd)**

Id. Number: **22**

Organic Constituents

	Average Concentration	Range
Oil and Grease	1.2%	0.6% to 1.8%
Total Organic & Volatile	66.5%	34.4% to 98.6%
Ethylene Glycol	3.5%	0.6% to 5.8%
Diethylene Glycol	1100 mg/kg	800 to 1500 mg/kg
Triethylene Glycol	5300 mg/kg	2700 to 7500 mg/kg

Notes on Analytical Data:

Note 1: Only trace metals listed in the Alberta Hazardous Waste Regulations, and which may influence the disposal of this waste in a landfill, are reported.

Note 2: Boron is used in deyhydration systems to stabilize glycol. Some forms of boron are toxic and are listed in the TDGR Schedule II, List II. No analytical data was found for boron.

Note 3: Glycols are subject to oxidative degradation resulting in the formation of organic acids. No analytical data was found on degradation products.

Note 4: Majority of organic and volatile is carbon.

4. Analytical Methods

1. Analytical data indicate that analysis were performed on both wet and dry filters. Water content ranged from 0.45% to 25.5%. All results have been connected to "wet basis."
2. Trace metals analysis were undertaken on leachates prepared according to the EPA leach protocol. The values reported, therefore, represent that portion of the trace elements and metals which are leachable. Metals were determined by Inductivey Coupled Plasma (ICP) Spectroscopy. No information is available regarding mercury and lead analysis. Usually these metals are determined by Atomic Absorption (AA) method.
3. Samples were analysed for total oil and grease using soxhlet extraction with hexane/acetone followed by gravimetric determination. Water was removed from the extract by sodium sulfate.
4. Glycol analysis were carried out by GC/MS. No information was found regarding the extraction methods or sample clean-up procedures used.
5. BTEX (volatiles) analysis are not reported.

5. Health Hazards and Safety Information

Toxicology (Significant Components):

Glycols - Most glycols have low volatility and consequently, present little danger from inhalation of vapours. Under ordinary conditions of industrial contact, most of the commonly used glycols are not considered toxic. Irritation effects: MOD, eye. May cause skin irritation upon prolonged exposure. MOD, oral.

Physical and Chemical Hazards:

Glycols - Will support fire, incompatible with strong alkalies. At high temperatures may decompose in the presence of O_2 to form CO and/or CO_2.

Waste Name: Filters - Glycol (Cont'd)

Id. Number: 22

6. Indicated Waste Classification:

TDGR Number (if listed): NA - 9500

TDGR Classification (if listed) 9.3
9.2 (Possibly)

Hazardous Classifications:

British Columbia:	Special Waste:	X
	Non-Special Waste:	
Alberta:	Hazardous:	X
	Non-hazardous:	

Rationale for Classification: Average lead concentrations in leachate extractions exceed 5.0 mg/L. As such, this waste meets the requirements of Class 9.3 under the TDGR and is, therefore, a hazardous waste in Alberta and a special waste in British Columbia.

In addition, since a number of lead compounds are listed as Class 9.2 in the TDGR, it is conceivable that this waste could be classified as hazardous or special if these compounds are present at concentrations exceeding 100 mg/kg.

7. References

Analytical Data:	6
Toxicology:	Sax, Sixth Edition, Union Oil MSDS
Analytical Methodology:	B. Davani et al., University of New Mexico (1984). J. Skinner, USEDA (1984).
Data Reliability:	D

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CANADIAN PETROLEUM ASSOCIATION

WASTE INFORMATION SHEET

1. **Waste Material Identification:** Id. Number: 23

Waste Name: Filters - Lube Oil (Hydrocarbon) Date: June 8, 1989.
Synonyms:
Chemical Name of Major Components:

Chemical Synonyms:

2. **Waste Material Source**

Hydrocarbon based lubricating oils are used on gas compressors, gas fed engines and turbine engines. These filters are used to remove corrosion products, degradation sludges and other impurities from the recirculating lubricating oil system.

3. **Significant Components and Average Concentrations**

Components	Average Concentration	Range
Inorganic Constituents		
Water	2.5%	2.1% to 2.8%
Fibre	62%	60.5% to 68.5%
Inorganic Residue (Ash)	5.3%	0.8% to 14.1%
Zinc	1125 mg/kg	150 to 2000 mg/kg
Phosphorous	2300 mg/kg	No range reported.
Trace Metals		
Arsenic	<0.01 mg/kg	<0.0025 to 0.57 mg/kg
Cadmium	2.31 mg/kg	1.00 to 7.6 mg/kg
Chromium (Cr^{+6})	9.0 mg/kg	3.00 to 11.6 mg/kg
Lead	269.5 mg/kg	62.3 to 381 mg/kg
Mercury	2.3 (ppb)	0.02 to 6.5 (ppb)
Nickel	3.8 mg/kg	2.6 to 4.56 mg/kg
Thallium	0.11 mg/kg	No range reported.
Selenium	No data available	
Organic Constituents		
Oil and Grease	0.85%	0.5 to 4.6%
Amines	155 mg/kg	No range reported.
Total Extractables	3.8%	1.2% to 25%

Waste Name: Filters - Lube Oil (Hydrocarbon) Cont'd

Id. Number: 23

Notes on Analytical Data:

Note 1: Only trace metals listed in the Alberta Hazardous Waste Regulations, and which may influence the disposal of this waste in a landfill, are reported.

Note 2: Amines are not identified, however these components are just likely filming type corrosion inhibitors.

Note 3: These filters may contain oil degradation products and mild acids. These components were not identified.

4. Analytical Methods

1. For trace metals analysis a wet ash method was used to prepare the sample for extraction at pH5.0 for 24 hours. Therefore the values reported represent the leachable amount of these metals. Analysis were carried out by Inductively Coupled Argon Plasma spectrometer (ICAP) methods.
2. Oil and grease values were determined according to EPA Material 413.1 after Soxhlet extraction with Freon followed by gravimetric residue determinations. It was noted that in 3 analytical procedures 1:1 hexane/acetone was used in place of the freon for the extraction of oil and grease and methanol was added to the extract during the evaporation step to ensure water removal in place of the sodium sulfate filtration.

5. Health Hazards and Safety Information

Toxicology (Significant Components):

Lubricating Oil (Petroleum Hydrocarbons): Details unknown. Irritant: slight, Allergies: slight, Toxicity by ingestion: slight.

Zinc: Toxicity variable depending on compound generally low. When heated may generate fumes of zinc oxide which when inhaled fresh may be harmful.

Phosphorous: Toxicity variable depending on compound. Most inorganic phosphates except phosphine (Hydrogen phosphide), have low toxicity.

Physical and Chemical Hazards:

Lubricating Oil: Flash point range: 150 to 250°C. Autoignition Point Range: 260 to 375°C. Fire hazard: slight when exposed to heat or flame. Can react with oxidizing materials.

6. Indicated Waste Classification:

TDGR Number (if listed): Not listed

TDGR Classification (if listed): 9.3 (Likely)
9.2 (Possibly)

Waste Name: **Filters - Lube Oil (Hydrocarbon) Cont'd**

Id. Number: **23**

Hazardous Classifications:

British Columbia:	Special Waste:	X
	Non-Special Waste:	
Alberta:	Hazardous:	X
	Non-hazardous:	

Rationale for Classification: Although leachate extraction test results were not found, it is likely that the concentrations of lead in leachates extracted from this waste will exceed 5.0 mg/L. As such, this waste will likely meet the criteria of Class 9.3 under the TDGR and will, therefore, be a hazardous waste in Alberta and a special waste in British Columbia.

In addition, since a number of lead and zinc compounds are listed as Class 9.2 in the TDGR, it is conceivable that this waste could be classified as hazardous or special if these compounds are present at concentrations exceeding 100 mg/kg.

7. References

Analytical Data:	6
Toxicology:	Sax, Sixth Edition
Analytical Methodology:	Mark J. Carter et al. RMAL, US-EPA (1985.)
Data Reliability:	C

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CANADIAN PETROLEUM ASSOCIATION

WASTE INFORMATION SHEET

1. Waste Material Identification: Id. Number: 25

Waste Name: Filters - Process Water Date: June 12, 1989
Synonyms: Waste Water Filters, Plant Effluent Filters, Recycle Water Filters
Chemical Name of Major Components: Iron Oxides, Calcium Carbonate
Chemical Synonyms:

2. Waste Material Source

Plant process waters are a combination of various plant effluent streams which include wash waters, waste lubricating oils, filter backwash and blowdown (both process and utility blowdowns) waters. Process water filters are used for the removal of sludges, corrosion products and other impurities from the process water prior to discharge via a disposal well or recycling. This waste is generated by most oil and gas processing facilities.

3. Significant Components and Average Concentrations

Components	Average Concentration	Range
Inorganic Constituents		
Fibres	63.1%	43.2% to 65.0%
Water	16.8%	5.2% to 21.0%
Inorganic Residue (Ash)	2.8%	1.6% to 7.0%
Corrosion Products (Iron Oxides)	0.85%	0.25% to 1.1%
Scale Products ($CaCO_3$)	0.31%	0.15% to 2.0%
Trace Metals		
Arsenic	0.06 mg/kg	<0.01 to 0.11 mg/kg
Cadmium	0.13 mg/kg	0.03 to 0.35 mg/kg
Chromium (Cr^{+6})	1.05 mg/kg	0.21 to 4.8 mg/kg
Lead	<0.005 mg/kg	0.001 to 0.005 mg/kg
Mercury	<0.05 mg/kg	<0.05 mg/kg
Nickel	1.05 mg/kg	0.05 to 2.15 mg/kg
Thallium	No data available	
Selenium	No data available	

Waste Name: **Filters - Process Water (Cont'd)**

Id. Number: **25**

Organic Constituents

	Average Concentrations	Range
Benzene/Xylene	46.8 mg/kg	16.5 to 143 mg/kg
Phenols	4.8 mg/kg	0.1 to 6.8 mg/kg
Paraffins/Olefins	1010 mg/kg	510 to 2050 mg/kg
Total Hydrocarbons	0.15%	0.1% to 0.26%
Oil & Grease	15.6 mg/kg	10.8 to 33.0 mg/kg

Notes on Analytical Data:

Note 1: Only these trace metals are reported which are listed in the Alberta Hazardous Waste Regulations and may influence the disposal of this waste in a landfill.

Note 2: Analytical results show that the accumulated organic and inorganic compounds on these filters is similar to those found in process pond waters and process pond sludges.

4. Analytical Methods

1. All analysis were performed on both "as received" and drained and/or cleaned filter elements.

2. Trace metals analysis were carried out on acid digested samples by Inductively Coupled Argon Plasma spectrometer (ICAP). The wet ash method is also acceptable. Mercury and lead analysis were carried out by flameless Atomic Absorption (AA) method.

3. Oil and grease content were determined by gravitimetric methods on freon extracted samples according to EPA Method 413.1. IR Relative Absorbance method, (EPA Method 413.2) measured at a 454 nm, is also used. These results should be used with caution since the method is specific for certain chromophones and may give low results.

4. Phenols were determined by spectrophotometric methods at 400 nm on chloroform extract following dehydration with anhydrous sodium sulphate. The method is based on the 4-aminoantipyrene method in general accordance with Standard Methods No. 510. No quality control data is reported.

5. Volatiles (Benzene/Xylene) were determined by GC/MS methods on extracts using acetone/hexane and acetic acid. Volatiles were determined after elution with methylene chloride from an alumina column. No quality control data is reported.

5. Health Hazards and Safety Information

Toxicology (Significant Components):

Paraffins/Olefins: Toxic Hazard Rating; None/Slight. Generally considered to be non-toxic and non-irritant.

Benzene/Xylene: Irritation effects: MOD eye, dermal, inhalation, oral.

Waste Name: Filters - Process Water (Cont'd)

Id. Number: 25

Physical and Chemical Hazards:

Paraffins/Olefins: Fire Hazard: Slight when exposed to heat or flame. May react with oxidizing materials.

Benzene/Xylene: Fire Hazard: Dangerous when exposed to heat or flame. May react with oxidizing materials. Explosion Hazard: MOD in form of vapour (range 1.1/1.3% to 7.0% in air).

6. Indicated Waste Classification:

TDGR Number (if listed): Not listed

TDGR Classification (if listed) Not listed

Hazardous Classifications:

British Columbia:	Special Waste:	
	Non-Special Waste:	X
Alberta:	Hazardous:	
	Non-hazardous:	X

Rationale for Classification: Based on the analytical data found, this waste does not appear to contain TDGR listed components in sufficient concentrations to warrant hazardous/special classification.

7. References

Analytical Data: 4
Toxicology: Sax, Sixth Edition
Analytical Methods: Standard Methods for the Examination of Water and Wastewater, 17th Edition (1985)
Availability: B

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CANADIAN PETROLEUM ASSOCIATION

WASTE INFORMATION SHEET

1. Waste Material Identification: Id. Number: 26

Waste Name: Filters - Produced Water Date: June 12, 1989
Synonyms: Water Injection Filters
Chemical Name of Major Components: Benzene, Toluene
Chemical Synonyms: Benzol, Phebylhydride, Tolual Phenylmethane

2. Waste Material Source

Produced waters are associated with the production of oil and natural gas. These filters are used for the removal of residual oils, corrosion products, sand, silt. Normally the organics found in produced water filters are those present in the oil and gas.

3. Significant Components and Average Concentrations

Components	Average Concentration)	Range
Inorganic Constituents		
Ash Content	23.5%	15.3% to 30.1%
Solids (Total)	68.3%	50.0% to 85.6%
Water	10.1%	5.05% to 17.8%
Calcium Carbonate	53.3%	46.5% to 58.9%
Clay/Silt	1.75%	0.8% to 3.95%
Corrosion Products (Iron Oxides)	0.8%	0.23% to 4.1%
Trace Metals		
Arsenic	<0.001 mg/kg	<0.001 mg/kg
Cadmium	0.02 mg/kg	0.01 to 0.05 mg/kg
Chromium (Cr^{+6})	1.5 mg/kg	0.5 to 2.08 mg/kg
Lead	No data available	
Mercury	<0.01 mg/kg	0.05 to 0.25 mg/kg
Nickel	<0.01 mg/kg	0.001 to 0.15 mg/kg
Thallium	No data available	
Selenium	No data available	

Waste Name: Filters - Produced Water (Cont'd)

Id. Number: 26

Organic Constituents

	Average Concentrations	Range
Organic & Volatile	1.65%	0.09% to 1.75%
Oil & Grease	2.01	0.95 to 2.4
Benzene	700	230 to 895
Toluene	120	165 to 215
Ethylbenzene	48	12.8 to 105

Notes on Analytical Data:

Note 1: Only trace metals listed in the Alberta Hazardous Waste Regulations, and which may influence the disposal of this waste in a landfill, are reported

Note 2: Available literature indicate that some produced waters have some produced wate filters may contain high arsenic levels (in the range of 50 to 100 mg/l), however, this could not be confirmed based on the analytical data found.

4. Analytical Methods

1. All analysis were performed on both "as received" and drained and/or cleaned filter elements.
2. Trace metals analysis were carried out on acid digested samples by Inductively Coupled Argon Plasma spectrometer (ICAP). The wet ash method is also acceptable. Mercury and lead analysis were carried out by flameless Atomic Absorption (AA) method.
3. Oil and grease content were determined by gravitimetric methods on freon extracted samples according to EPA Method 413.1. IR Relative Absorbance method, (EPA Method 413.2) measured at a 454 nm, is also used. These results should be used with caution since the method is specific for certain chromophones and may give low results.
4. BTEX (volatiles) analysis are not reported.
5. Corrosion product (Iron Oxide) analysis were done on two acid degested samples of filter segments. One was done by ICAP and the other by AA. The results were 3.25% and 3.62% respectively.
6. The presence of benzene in the filters may be attributed to the solubility of aromatic hydrocarbons which are present in the crude oil or natural gas that has ben in contact with the produced water.
7. No information is available regarding the method used for organic identification.

Waste Name: **Filters - Produced Water (Cont'd)**

Id. Number: **26**

5. Health Hazards and Safety Information

Toxicology (Significant Components):

Benzene - TLV: Poisoning occurs most commonly via inhalation of vapour. Irritation effects: Benzene is a relatively strong irritant. MOD/SEV via inhalation, oral, dermal. SEV. eye.

Toluene - TLV: Poisoning occurs most commonly via inhalation of vapour. Has narcotic effect. Irritation effects: MOD/SEV. via oral, inhalation. MOD dermal, eye.

Physical and Chemical Hazards:

Benzene: Dangerous. SEV Fire Hazard. Can react vigorously with oxidizing materials. MOD. Violent Explosion hazard (range 1.4 to 8.0% in air) will emit toxic fumes.

Toluene: Dangerous. SEV Fire Hazard when exposed to heat or flame. MOD. Explosion hazard (range 1.27 to 7.0% in air).

6. Indicated Waste Classification:

TDGR Number (if listed):

TDGR Classification (if listed) 9.3 (Likely)

Hazardous Classifications:

British Columbia:	Special Waste:	X
	Non-Special Waste:	
Alberta:	Hazardous:	X
	Non-hazardous:	

Rationale for Classification: Since both benzene and toluene are listed as Class 9.2 in the TDGR, and occur at average concentrations greater than 100 mg/kg, these filters will be a hazardous waste in Alberta and a special waste in British Columbia.

Waste Name: Filters - Produced Water (Cont'd)

Id. Number: 26

7. References

Analytical Data:	3
Toxicology:	Sax, Sixth Edition
Analytical Methods:	ERT - Report to to API, Oil and Gas Industry Exploration and Production Wastes (1987)
Data Availability:	C

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CANADIAN PETROLEUM ASSOCIATION

WASTE INFORMATION SHEET

1. Waste Material Identification: Id. Number: 27

Waste Name: Filters - Raw Water Date: June 8, 1989.
Synonyms: Source Water Filters, Water Injection Filters
Chemical Name of Major Components:
Chemical Synonyms:

2. Waste Material Source

These filters are normally used for the removal of sand, silt and corrosion products from supply waters in facilities without pre-treatment facilities. These filters are generated mainly by facilities using surface water, however, well water filtration filters are also included.

3. Significant Components and Average Concentrations

Components	Average Concentration)	Range
Inorganic Constituents		
Corrosion Products (Iron Oxides)	0.16%	0.11 to 0.19%
Inorganic Residue (Ash)	3.6%	2.05% to 6.1%
Water	8.4%	5.9% to 11.5%
Sand/Silt	4.0%	1.3% to 6.7%
Trace Metals		
Arsenic	<0.001 mg/kg	<0.001 mg/kg
Cadmium	0.01 mg/kg	0.005 to 0.02 mg/kg
Chromium (Cr^{+6})	1.3 mg/kg	0.03 to 2.1 mg/kg
Lead	<0.001 mg/kg	<0.001 mg/kg
Mercury	0.02 mg/kg	0.01 to 0.073 mg/kg
Nickel	<0.01 mg/kg	0.01 to 0.07 mg/kg
Thallium	No data available	
Selenium	No dta available	
Organic Constituents		
Oil & Grease	0.04%	0.01% to 0.08%
Humic Acids	80.5 mg/kg	21.5 to 165 mg/kg
Hydrocarbons	Not detected	

Notes on Analytical Data:

Note 1: Only trace metals listed in the Alberta Hazardous Waste Regulations, and which may influence the disposal of this waste in a landfill, are reported.

Waste Name: **Filters - Raw Water Cont'd**

Id. Number: **27**

Note 2: Relatively high chromate levels are most likely due to the use of chromate based corrosion inhibitors used in some raw water systems.

Note 3: High lead levels reported could not be confirmed with additional analytical data.

4. Analytical Methods

1. All analysis were performed on both "as received" and drained and/or cleaned filter elements.
2. Trace metals analysis were carried out on acid digested samples by Inductively Coupled Argon Plasma spectrometer (ICAP). The wet ash method is also acceptable. Mercury and lead analysis were carried out by flameless Atomic Absorption (AA) method.
3. Oil and grease content were determined by gravitimetric methods on freon extracted samples according to EPA Method 413.1.
4. Humic acid (natural organics) were determined by IR Relative Absorbance analysis (EPA Method No. 413.2) measured on 454 nm. These results should be used with caution since the method is specific for certain chromophores and may give low results.

5. Health Hazards and Safety Information

Toxicology (Significant Components):
The components present in the raw water supply and the residual materials accumulating on these filters are generally considered to be non-hazardous and non-irritating.

Physical and Chemical Hazards:
There are no fire, explosion, decomposition or reactive hazards associated with this waste material.

6. Indicated Waste Classification:

TDGR Number (if listed): N/A

TDGR Classification (if listed): N/A

Hazardous Classifications:

British Columbia:	Special Waste:	
	Non-Special Waste:	X
Alberta:	Hazardous:	
	Non-hazardous:	X

Waste Name: **Filters - Raw Water Cont'd**

Id. Number: **27**

Rationale for Classification:	There are no TDGR listed materials present in this waste. It is unlikely that leachate extraction procedures would result in concentration of listed materials above the limits. Therefore, this waste is considered to be non-hazardous.

7. References

Analytical Data:	4
Toxicology:	Sax, Sixth Edition
Analytical Methodology:	J.F. Selann et al. Identification vs. Characterization of Organics (1987)
Data Reliability:	B

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CANADIAN PETROLEUM ASSOCIATION

WASTE INFORMATION SHEET

1. **Waste Material Identification:** Id. Number: 28

Waste Name: Filters - Sulfinol Date: June 12, 1989.
Synonyms: Sulfolane/diisopropanolamine (DIPH)
Chemical Name of Major Components: Sulfolane, Diisopropanolamine
Chemical Synonyms: Tetrahydro-1, 1 dioxide-thiophene

2. **Waste Material Source**

Sulfinol, a hybrid physical/chemical solvent process, is used for the removal of acid gases from sour natural gas. It is estimated that 5 to 7% of sour gas processing plants use the sulfinol process. These filters are used for the removal of corrosion products and other impurities from the recirculating solvent solution.

3. **Significant Components and Average Concentrations**

Components	Average Concentration)	Range
Inorganic Constituents		
Inorganic Ash	0.57%	No range reported
Iron Sulphide	0.8%	No range reported
Moisture	65.5%	58.5% to 91%
Trace Metals		
Arsenic	0.20 mg/kg	0.011 to 0.032 mg/kg
Cadmium	<0.01 mg/kg	
Chromium (Cr^{+6})	<0.01 mg/kg	
Lead	133.0 mg/kg	0.15 to 400 mg/kg
Mercury	<0.003 mg/kg	<0.003 to 0.004 mg/kg
Nickel	<0.1 mg/kg	
Thallium	No available data	
Selenium	No available data	
Organic Constituents		
Sulfolane	0.53%	0.15% to 0.91%
Phenolics	0.15%	Not reported
PCB	<1.0 ppm	Not reported
Diisopropanolamine	0.26%	0.15% to 0.31%
Amine Degradation Products	0.46%	

Waste Name: Filters - Sulfinol (Cont'd)

Id. Number: 28

Notes on Analytical Data:

Note 1: Only trace metals listed in the Alberta Hazardous Waste Regulations, and which may influence the disposal of this waste in a landfill, are reported.

Note 2: Only limited analytical data was found for this waste (2 analysis). Therefore, some inference was drawn from reclaimer bottoms sludge analysis.

Note 3: The only sulfinol degradation product identified by GD is Z-oxazolidinone (OX).

Note 4: Phenolics include Phenol, 2, 4-Dimethylphenol and Or, M, and p-cresol.

4. Analytical Methods

1. Trace metal analysis were carried out on acid digested samples by Inductively Coupled Argon Plasma Spectrometer (ICAP). No information is available specifically on lead and mercury analysis. Atomic Absorption (AA)is the most accurate method for these elements having lower detection limits.
2. Phenolic Compounds were determined by the A-amino antipyrine colorimetric analysis according to EPA Method 420.2.
3. For residual intractable compounds, including Sulfinol, gas chromatography/flame photometric detection analysis were used. Sulfinol was determined on the methyl alcohol extract. Sample analysis were conducted by comparing instrument responses for standard Sulfinol solutions in methyl alcohol against responses for sample extract. The recovery of Sulfinol, based on the standard solution, is confirmed.
4. Sulfinol degradation products were identified by GC/MS methods. Extraction and fractionation procedures are not known.

5. Health Hazards and Safety Information

Toxicology (Significant Components):

Sulfolene - Most of the glycols have low volatility and consequently, present little danger from inhalation of vapours. Under ordinary conditions of industrial contact, most of the commonly used glycols are not considered to be toxic.

Diisopropanolamine - Irritation effects: SEV. eye, MOD via oral, dermal.

Amine Degradation Products - 2-oxazalidinone (OV) was the only degradation product positively identified. Only limited toxicology information was located on this compound. A reference cited in Sax (1979) indicates that it is carcinogenic. However, Sax (1981) classifies this compound as a "Suggestive" animal carcinogen, indicating that evidence to-date is conflicting or inconclusive.

Physical and Chemical Hazards:

Diisopropanolamine - Dangerous when exposed to heat or flames. Can react violently with oxidizing materials. May emit toxic fumes of NO_2.

Waste Name: Filters - Sulfinol (Cont'd)

Id. Number: 28

6. Indicated Waste Classification:

TDGR Number (if listed): N/A

TDGR Classification (if listed) N/A

Hazardous Classifications:

British Columbia:	Special Waste:	X
	Non-Special Waste:	
Alberta:	Hazardous:	X
	Non-hazardous:	

Rationale for Classification: Although leachate extraction test results were not found, it is likely that the concentrations of lead in leachates extracted from this waste will exceed 5.0 mg/L. As such, this waste wil likely meet the criteria of Class 9.3 under the TDGR and will, therefore, be a hazardous waste in Alberta and a special waste in British Columbia.

In addition, since a number of the phenolic compounds identified are listed as Class 9.2 in the TDGR (phenol, (, M & P cresol) it is conceivable that this waste could be cliassified as hazardous or special if these compounds are present at concentrations exceeding 100 mg/kg. Given that total phenolics have been reported at concentrations of 0.15% (1500 mg/kg), this is highly likely.

7. References

Analytical Data:	5
Toxicology:	Sax, (1979) (1981), ACS Chemical Abstracts Service
Analytical Methodology:	B.C. Research
Data Reliability:	D. (Further work is recommended).

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CANADIAN PETROLEUM ASSOCIATION

WASTE INFORMATION SHEET

1. Waste Material Identification: Id. Number: 54

Waste Name: Process Waste Water Date: June 8, 1989.
Synonyms:
Chemical Name of Major Components: Benzene, Toluene, Lead, Chromium
Chemical Synonyms:

2. Waste Material Source

Process waste water is a combination of a large variety of waters which are specific to a given oil production or gas procesing facility. These streams include but are not limited to wash waters, cooling waters, drainage and plantsite run-off waters, etc. These wastes are typically collected via a series of sumps into central process waste water storage or evaporation pits. Process waste waters are generated by all oil and gas production facilties.

3. Significant Components and Average Concentrations

Components	Average Concentration)	Range
Inorganic Constituents		
pH	9.3	7.6 to 9.8
Corrosion Products (Iron Oxides)	230 mg/kg	55 to 612 mg/kg
Scale Products (CaCO3)	830 mg/kg	590 to 2650 mg/kg
Sand/Silt	45 mg/kg	2.0 to 11,500 mg/kg
TDS. (Conductivity)	1360 mmh	725 mmh to 6450 mmh
Trace Metals		
Arsenic	<0.001 mg/kg	<0.001 mg/kg
Cadmium	0.06 mg/kg	0.01 to 0.15 mg/kg
Chromium (Cr^{+6})	2.55 mg/kg	1.02 to 10.5 mg/kg
Lead	107.5 mg/kg	83 to 146.5 mg/kg
Mercury	0.08 mg/kg	No range found
Nickel	0.85 mg/kg	0.5 to 1.85 mg/kg
Thallium	165 mg/kg	15.3 to 925 mg/kg
Selenium	No data available	
Organic Constituents		
	Average Concentration	Range
BETX (Volatiles)	365 mg/kg	250 to 1150 mg/kg
Hydrocarbons	0.05%	0.01% to 0.10%
Oil & Grease	0.13%	0.08% to 0.33%
Pyrene	810 mg/kg	345 to 5000 mg/kg
PAH.s	165 mg/kg	15.3 to 925 mg/kg

Waste Name: Process Waste Water Cont'd

Id. Number: 54

Notes on Analytical Data:

Note 1: Only trace metals listed in the Alberta Hazardous Waste Regulations, and which may influence the disposal of this waste in a landfill, are reported.

Note 2: Only Cr^{+6} chromate is reported. If the waste contains high levels of sulphides this material may be reduced to Cr^{+3} and would not be reported.

Note 3: Only limited analytical data was found for BETX materials and for Pyrene. The high range reported could not be confirmed.

4. Analytical Methods

1. All analysis were performed on both "as received" and drained and/or cleaned filter elements.
2. These samples appeared to contain a significant amount of silt/sand/clay type of material. It is expected that these are the result of surface run-off contamination.
3. Oil and grease analysis were carried out using soxhlet extraction with lexane/acetone followed by filtration through sodium sulphate to remove water and the residue on evaporation of solvents was determined gravimetrically.
4. No information is available regarding the method used for Pyrene identification.

5. Health Hazards and Safety Information

Toxicology (Significant Components):

BETX (Volatiles): Irritation effects: MOD/SEV eye, dermal, inhalation, oral.

Polyaromatic Hydrocarbons (PAH): These compounds (including Naphthalenes and Phenonthrene) are generally toxic and possibly carcinogens. Irritation effects: SEV. eye, oral. MOD via dermal. TLV: Not available.

Pyrene: No information available.

Physical and Chemical Hazards:

BETX (Volatiles): In general, these compounds are dangerous. Fire Hazard: SEV. Can react with oxidizing materials. Explosion Hazard: MOD. May emit toxic fumes upon decomposition.

Poly Aromatic Hydrocarbons (PAH): Fire Hazard, MOD when exposed to heat or flame. These compounds can react with oxidizing materials. Explosion hazard: MOD.

Pyrene: No information available.

Waste Name: **Process Waste Water Cont'd**

Id. Number: **54**

6. Indicated Waste Classification:

TDGR Number (if listed): 374 (Item No. 1115)

TDGR Classification (if listed): 3.1, 3.2 (Flammable Liquids)

Hazardous Classifications:

British Columbia:	Special Waste:	X
	Non-Special Waste:	
Alberta:	Hazardous:	X
	Non-hazardous:	

Rationale for Classification: Although leachate extraction test results were not found, it is likely that the concentrations of lead in leachates extracted from this waste will exceed 5.0 mg/L. As such, this waste will likely meet the criteria of Class 9.3 under the TDGR and will, therefore, be a hazardous waste in Alberta and a special waste in British Columbia.

In addition, since benzene, toluene and xylene compounds are listed as Class 9.2 in the TDGR, it is conceivable that this waste could be classified as hazardous or special if these compounds are present at concentrations exceeding 100 mg/kg. Given that BETX concentrations average 365 mg/kg, this is highly likely.

7. References

Analytical Data:	4
Toxicology:	Sax, Sixth Edition
Analytical Methodology:	
Data Reliability:	C

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CANADIAN PETROLEUM ASSOCIATION

WASTE INFORMATION SHEET

1. **Waste Material Identification:** Id. Number: 55

Waste Name: Produced Sand Date: June 12, 1989
Synonyms: Ecology Pit Sludge, Treater Bottom Sludge, Field Separator Tank Sludge, Desand Sludge, Oily Sludge
Chemical Name of Major Components:
Chemical Synonyms:

2. **Waste Material Source**

This waste is generated predominately in heavy oil production operation facilities. It includes the sand, oil and water mixture contained in the bottom of field separator tanks, treaters, storage tanks and ecology pits. It also includes the sand, oil and water mixture produced from desanding processes (e.g. hydrocylones) where these processes are used to reduce both the volume and oil content of produced sand obtained from the previously mentioned sources. Therefore, the composition of the specific produced sand sample will be highly dependent upon its source and any treatment process which it may have undergone.

3. **Significant Components and Average Concentrations**

Components	Average Concentration	Range	
Water	23.8%	4.6% to 46.3%	Note 3
Oil	28.6%	1.6% to 87.0%	Note 3
Solids	46.7%	1.6% to 91.0%	Note 3
Specific Gravity	1.1	0.84 to 1.56	
Inorganic Constituents			
pH	7.0	5.8 to 12.6	
Calcium	3710 mg/kg	83 to 9500 mg/kg	
Magnesium	525 mg/kg	24 to 1210 mg/kg	
Sodium	1943 mg/kg	150 to 4150 mg/kg	
Chlorides	4569 mg/kg	121 to 10100 mg/kg	
Carbonates	6914 mg/kg	300 to 21800 mg/kg	
Trace Metals			
Arsenic	6.5 mg/kg	0.5 to 18.0 mg/kg	
Cadmium	1.7 mg/kg	0.1 to 5.3 mg/kg	
Chromium (Cr^{+6})	0.28 mg/kg	0.03 to 0.97 mg/kg	
Lead	24.3 mg/kg	2.2 to 90.1 mg/kg	
Mercury	0.20 mg/kg	0.009 - 1.1 mg/kg	
Nickel	7.4 mg/kg	1.5 to 24.1 mg/kg	
Thallium	No data available		
Selenium	No data available		

Waste Name: Produced Sand (Cont'd)

Id. Number: 55

Organic Constituents

	Average Concentration	Range	
Asphaltenes	15.0%	5% to 19%	Note 4
Resins	13.3%	9% to 25%4	Note 4
Acids	1.8%	0.1% to 13%	Note 4
Bases	0.4%	0.4% to 1%	Note 4
Neutral Nitrogens	16.5%	12% to 25%	Note 4
Aliphatics	36.6%	28% to 39%	Note 4
Aromatics	17.5%	11% to 23%	Notes 1&4
Phenol	Not reported	0 to 370 mg/kg	Note 5

Notes on Analytical Data:

Note 1: Aromatics include Napthalene, Alberrzothiophene, Benanthrene, Fluorene, Fluoranthane, Benzonaphthothiophene.

Note 2: Only trace metals listed in the Alberta Hazardous Waste Regulations, and which may influence the disposal of this waste in a landfill, are reported.

Note 3: Wide variances in oil, water and solids concentrations reflect both differences in waste definition and handling/treatment techniques.

Note 4: Percentages represent percent of oil fraction.

Note 5: No specific analytical data found. However, this range was referenced in Varem & Ng (1983).

4. Analytical Methods

Trace metals were determined after acid digestion by Inductively Coupled Plasma (ICP), Plasma Emission Spectroscopy (ICAP), Atomic Absorption (AA) or wet chemical methods in some cases, complete digestion by burning followed by acid digestion was performed for overall metals analyses, so as to ensure complete release of metals bound to organic compounds.

Information regarding the analytical methods for organics is very limited. In general, analyses are carried out using solvent extraction and Gar Chromatography/Flame Ionization Detector (GC/FID) techniques. No information is available regarding the verification of the extraction procedure efficiency.

5. Health Hazards and Safety Information

Toxicology (General)

Microtox: EC_{50}'s range from 70% to greater than 100% for leachates generated from distilled water and produced sand.

Algae Bioarrays: EC_{50}'s range from 4.2% to greater than 100% for leachates generated from distilled water and produced sand.

Waste Name: **Produced Sand (Cont'd)**

Id. Number: **55**

Invertebrate Bioassays: Filtered leachates generated from distilled water and produced sand were found to be non-toxic at 10% and 50% concentrations. Unfiltered leachates were found to cause 87% mortality at 10% concentrations.

Fish Bioassays: Leachates generated from distilled water and produced sand showed very minor toxicity to trout.

Toxicology (Significant Components):

Asphaltenes: Irritation effects: MOD via oral, inhalation. Slight via dermal.

Aromatics: In general, the toxicity of these materials is MOD. TLV is unknown. Irritation effects range from slight to MOD via eye, dermal, inhalation, oral. Some aromatics are suspected CAR.

Aliphatics: These materials are generally not considered to be health or environmental hazards.

Physical and Chemical Hazards:

Asphaltine: Fire Hazard: Slight when exposed to heat or flame.

Aromatics: Fire Hazard: Dangerous when exposed to heat or flame. Can react vigorously with oxidizing agents. Explosion Hazard: MOD in the vapor form (range 1.4% to 8.0%). May emit toxic fumes if heated to decomposition.

Aliphatics: Fire Hazard: SEV dangerous when exposed to heat or flame. Specially short chain hydrocarbons are reactive. Explosion Hazard: MOD (range: 1.2/1.3% to 6.0% in air).

6. Indicated Waste Classification:

TDGR Number: Not Listed

TDGR Classification: Not Listed

Hazardous Classifications:

British Columbia:	**Special Waste:**	
	Non-Special Waste:	X
Alberta:	**Hazardous:**	
	Non-hazardous:	X

Rationale for Classification: Based on the analytical data found, this waste does not appear to contain TDGR listed components in sufficent concentrations to warrant hazardous/special classification.

Waste Name: **Produced Sand (Cont'd)**

Id. Number: **55**

N.B. **The produced sand could be classified as hazardous depending upon the concentrations of phenol and napthalene. Both of these substances are listed under Class 9.2 of the TDGR and hence, should their concentrations exceed 0.01% by mass, the produced sand would carry a hazardous/special classification. This would occur only in produced sand having high concentration of oil.**

7. References

Analytical Data:	Overall -	Inorganics - 12 Organics - 0
	Oil Fraction -	Inorganics - 7 Organics - 9
	Water Fraction	Inorganics - 7 Organic - 0
Toxicology:	General, Swanson and Toner (1988) Specific Components - Sax, Sixth Edition	
Analytical Methodology:		
Data Reliability:	B	

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CANADIAN PETROLEUM ASSOCIATION

WASTE INFORMATION SHEET

1. **Waste Material Identification:** Id. Number: 59, 60, 61, 62

Waste Name: Sludge - Tank Bottoms
Synonyms: Crude Oil Stock Tanks, Oil Slop Tanks
Chemical Name of Major Components:
Chemical Synonyms:

Date: June 12, 1989

2. **Waste Material Source**

"Bottoms" are basic sediments, water and other materials that collect in the lower sections of treating and storage facilities such as production separators, fluid treating vessels and production impoundments. Materials found with "bottoms" include accumulated heavy hydrocarbons, solids, sand and emulsions. This waste is found predominantly in conventional and heavy crude oil production facilities.

3. **Significant Components and Average Concentrations**

Components	Average Concentration	Range
Inorganic Constituents		
Sillicates (Sand)	38.3%	16.5% to 55.5%
Total Solids	75.5%	73.5% to 76.0%
Ferric/Ferrous Oxides	21.8%	10.5% to 38.7%
Iron Sulphide	2.3 mg/kg	1.8% to 4.6%
Water	15.5%	7.8% to 22.0%
Zinc	704.0 mg/kg	No range available
Titanium	4208 mg/kg	No range available
Barium	250.0 mg/kg	No range available
Boron	178.0 mg/kg	No range available
Trace Metals		
Arsenic	4.94 mg/kg	490 to 5.03 mg/kg
Cadmium	1.55 mg/kg	<0.01 to 4.51 mg/kg
Chromium (Cr^{+6})	141.0 mg/kg	53.5 to 228 mg/kg
Lead	155.0 mg/kg	110 to 193 mg/kg
Mercury	1.35 mg/kg	<0.01 to 3.15 mg/kg
Nickel	155 mg/kg	36.5 to 310.0 mg/kg
Thallium	No data available	
Selenium	No data available	

Waste Name: Sludge - Tank Bottoms (Cont'd)

Id. Number: 59, 60, 61, 62

Organic Constituents

	Average Concentration	Range
Oil & Grease	17.5%	15.3% to 24.5%
Hydrocarbons	2.3%	1.70% to 6.30%
BETX (Volatiles)	125.0 mg/kg	No range available
Naphthalene	12.5 mg/kg	1.6 to 183.5 mg/kg
Phenols	83.0 mg/kg	45.4 to 263.0 mg/kg

Notes on Analytical Data:

Note 1: Only trace metals listed in the Alberta Hazardous Waste Regulations, and which may influence the disposal of this waste in a landfill, are reported.

Note 2: The wide range of constituents reported indicate that the composition of these sludges is specific to given type of production operation and the method of handling this waste.

Note 3: The available literature indicate that in addition to the organic compounds identified, this waste may also contain fluorene, penatrene, fluoranthanl pyrene, a variety of benzene derivatives and a large variety of other organic compounds, some of which are EPA priority pollutants. However, no analytical data was found to quantify these components.

4. Analytical Methods

1. Trace metals analysis were carried out on acid digested samples by Inductively Coupled Argon Plasma spectrometer (ICAP). The wet ash method is also acceptable. Mercury and lead analysis were carried out by flameless Atomic Absorption (AA) method.

2. Oil and grease content was determined by gravitimetric methods on freon extracted samples according to EPA Method 413.1. IR Relative Absorbance Method, (EPA Method 413.2) measured at a 454 nm, is also used. These results should be used with caution since the method is specific for certain chromophones and may give low results.

3. Organic identification work was undertaken by GC/MS analysis on methylene chloride extracts. Fractionation prior to GC/MS is by mixed media Silica Gel/Alumina Chromatographic Column eluted with Hexane/Toluene and Methanol. No data was found regarding the efficiency of the organics extraction/fractionation procedures.

5. Health Hazards and Safety Information

Toxicology (Significant Components):

Chromium (Cr^{+6}) Compounds: Not Available. Irritation effects: SEV. eye, oral, dermal. In general, chromic acid salts have a corrosive action on skin and on mucous membranes. Chromate salts have been associated with cancer of the lungs.

Waste Name: Sludge - Tank Bottoms (Cont'd)

Id. Number: 59, 60, 61, 62

Mercury Compounds (Inorganic):	Mercury is a general protoplasmic poison. Irritation effects: SEV oral, inhalation, dermal, eye. MOD/SEV chronic irritant.
Nickel Compounds:	These compounds are generally not considered systemic toxins. Irritation effects: MOD via eye, oral, dermal and inhalation.
Phenolics:	Irritation effects: SEV eye, MOD skin MOD via oral.

Physical and Chemical Hazards:

Chromium (CR^{+6}) Compounds:	These compounds, in general, are oxidizing agents. May react violently with reducing agents. (May react with sulphides).
Mercury Compounds:	Dangerous when heated to decomposition, may emit highly toxic fumes of mercury.
Nickel Compounds:	Slight fire hazard when heated or in contact with flame. Generally considered non-reactive.
Phenolics:	Can react with oxidizing materials. Dangerous; when heated it emits toxic fumes.

6. Indicated Waste Classification:

TDGR Number (if listed): 2297 (Phenolics)
3079 (Xylenes)
(NA 9500)

TDGR Classification (if listed): 9.3 (Likely)
9.2 (Possibly)
3.3 (Possibly)

Hazardous Classifications:

British Columbia:	Special Waste:	X
	Non-Special Waste:	
Alberta:	Hazardous:	X
	Non-hazardous:	

Rationale for Classification: Although leachate extraction test results were not found, it is likely that the concentrations of lead and chromium in leachates extracted from this waste will exceed 5.0 mg/L. As such, this waste will likely meet the criteria of Class 9.3 under the TDGR and will, therefore, be a hazardous waste in Alberta and a special waste in British Columbia.

In addition, since a number of lead, chromium and zinc compounds are listed as Class 9.2 in the TDGR, it is conceivable that the waste could be classified as hazardous or special if these compounds are present at concentrations exceeding 100 mg/kg.

Waste Name: Sludge - Tank Bottoms (Cont'd)

Id. Number: 59, 60, 61, 62

7. References

Analytical Data:	7
Toxicology:	H. Seiler et al. Handbook on Toxicity of Inorganc Compounds (1987) Sax, Sixth Edition D.J. DeRenzo et al. Solvent Safety Handbook (1986)
Analytical Methods:	
Data Availability:	B

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CANADIAN PETROLEUM ASSOCIATION

WASTE INFORMATION SHEET

1. Waste Material Identification: Id. Number: 63, 64, 65, 75.

Waste Name: Sludges - Gas Sweetening. Date: June 8, 1989.
Synonyms: Reclaimer bottoms, Filter Sludges.
Chemical Name of Major Components: Diethanolamine, Monoethanolamine, Sulfolane, Diisopropanolamine (DIPA), Iron Sulphide.
Chemical Synonyms: Di (2-hydroxyethyl) amine. 2-Aminoethanol, Tetrahydro-1, 1 dioxide-thiophene.

2. Waste Material Source

This waste is generated by acid gas removal processes in sour gas plants. It includes the alkanolamine (DEA and MEA) and sulfinol processes. While process details range from plant to plant, generally sludges from those processes include reclaimer bottoms and filter sludges.

The sludges produced in gas sweetening are primarily due to the degradation of the acid gas absorption chemicals and to the accumulation of corrosion products in the system. The most widely used solvents are DEA and MEA. It is estimated that approximately 125 sour gas plants use these processes in Canada. The sulfinol process (sulfolane/DIPA) is used in approximately 15 plants. Sweet gas plants which remove CO_2 may also generate small quantities of these sludges.

3. Significant Components and Average Concentrations

Components	Average Concentration	Range
Inorganic Constituents		
Suspended Solids	25,000 mg/kg	12,000 to 45,000 mg/kg
Total Dissolved Solids	12,500 mg/kg	8400 to 65,000 mg/kg
Total Sulpher	0.21%	0.15% to 0.57%
Water	86.5%	69.5 to 98.8%
Ash Content	8.5%	5.05 to 12.0%
Total Cyanide	High variance	up to 200
Vanadium	360 mg/kg	0 to 650 mg/kg
Trace Metals		
Arsenic	0.05 mg/kg	0.01 to 15.0 mg/kg
Cadmium	215 mg/kg	0.1 to 950 mg/kg
Chromium (Cr^{+6})	36 mg/kg	1.0 to 67.0 mg/kg
Lead	405 mg/kg	0.5 to 1000 mg/kg
Mercury	0.29 mg/kg	0.01 to 3.5 mg/kg
Nickel	14 mg/kg	0.2 to 35 mg/kg
Thallium	<0.0.5 mg/kg	Not reported
Selenium	No data available	

Waste Name: Sludges - Gas Sweetening Cont'd

Id. Number: 63, 64, 65, 75.

Organic Constituents

	Average Concentration	Range
Sulfolane	1300 mg/kg	350 to 7500 mg/kg
Diisopropanolamine (DIPA)	2300 mg/kg	150 to 10,800 mg/kg
Phenolics	9000 mg/kg	500 to 25,000 mg/kg
Diethanolamine (DEA)	2500 mg/kg	1500 to 3600 mg/kg
PCB's	<1 PMM	Not reported
Glycol (m, d, t)	1022 mg/kg	250 to 3000 mg/kg
Monoethanolamine (MEA)	600 mg/kg	75 to 15,000 mg/kg
Amine degradation products	Variable	0.5 to 60%
Oil and Grease	1.5%	1.0% to 3.5%

Notes on Analytical Data:

Note 1: Only trace metals listed in the Alberta Hazardous Waste Regulations, and which may influence the disposal of this waste in a landfill, are reported.

Note 2: The form in which vanadium is present in these wastes was not identified. However it is likely V^{+4} or V^{+5} and is not a stable salt.

4. Analytical Methods

1. All analysis, whether performed as Dry Sludge or in "as received" samples are reported on a wet weight basis.
2. Trace metals analysis were carried out on acid digested samples by Inductively Coupled Argon Plasma (ICAP) spectrometer. No information is available specifically on lead and mercury analysis.
3. For organic analysis the samples were usually fractionated by solvent elution from aluminum column into 4 fractions, i.e. saturates (pentane), aromatic hydrocarbons/aromatic sulphur heterocycles (benzene), aromatic nitrogen heterocycles (chloroform) and hydroxy polycyclic aromatics (water/methanol). Analysis were undertaken by GC/FID (semi quantitative). Individual organics were identified and quantified by GC/MS analysis.
4. It is to be noted that most of the complex organics (approx. 80%) are non-gas chromatographable. Therefore it is important to undertake gravimetric residue determination on the extract.
5. BTEX analysis are not reported. Only limited data was found for these components, (3 analysis) and these indicated that very little BTEX is present in gas sweetening sludges.
6. There are no standard methods for the determination of organic compounds in sludges. Wide variance in sample preparation and sample clean-up procedures was noted.

5. Health Hazards and Safety Information

Toxicology (Significant Components):

Phenolics:	Irritation Effects: SEV eye, MOD skin, MOD via oral.
Monoethanolamine:	Irritation Effects: SEV eye, MOD skin, MOD via oral.
Diethanolamine:	Irritation Effects: slight.
Diisopropanolamine:	Irritation Effects: LOW to MOD, via oral. Skin and eye irritation.

Waste Name: Sludges - Gas Sweetening Cont'd

Id. Number: 63, 64, 65, 75

Physical and Chemical Hazards:

Phenols	- Can react with oxidizing materials. Dangerous; when heated it emits toxic fumes.
Diethanolamine	- Slight fire hazard when exposed to heat or flame. Can react with oxidizing materials.
Monoethanolamine	- Moderate fire hazard when exposed to heat or flame. Can react with oxidizing materials.
Diisopropanolamine	- When heated to decomposition it emits toxic fumes of NO_2.

6. Indicated Waste Classification:

TDGR Number (if listed):

TDGR Classification (if listed): 9.3 (Likely)
9.2 (Possibly)
6.1 (Possibly)
8 (Possibly)

Hazardous Classifications:

British Columbia:	Special Waste:	X
	Non-Special Waste:	
Alberta:	Hazardous:	X
	Non-hazardous:	

Rationale for Classification:

Although leachate extraction test results were not found, it is likely that the concentrations of lead and cadmium in leachates extracted from this waste will exceed 5.0 mg/L and 0.5 mg/L respectively. As such, this waste will likely meet the criteria of Class 9.3 under the TDGR and will, therefore, be a hazardous waste in Alberta and a special waste in British Columbia.

In addition, since a number of lead, cadmium and vanadium compounds are listed under Class 9.2 in the TDGR, it is conceivable that the waste could be classified hazardous/special if these compounds are present at concentrations exceeding 100 mg/kg. Furthermore, it is believed that these sludges could be classified as Class 6.1 (Toxic) under the TDGR based on a calculated LD 50 of the waste.

It should also be noted that based on average cadmium concentrations, this waste could not be diposed of in a landfill in Alberta.

Waste Name: Sludges - Gas Sweetening Cont'd

Id. Number: 63, 64, 65, 75

7. References

Analytical Data:	11
Toxicology:	Sax, Sixth Edition, K Verschueren et al (1988)
Analytical Methodology:	L. Skinner, USEPA, D. A. Birkholz, ETI.
Data Reliability:	C

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CANADIAN PETROLEUM ASSOCIATION

WASTE INFORMATION SHEET

1. Waste Material Identification: Id. Number: 31

Waste Name: Sludges - Flare Knock-Out Date: June 13, 1989
Synonyms:
Chemical Name of Major Components: Iron Oxides, Iron Sulphides, Aluminum Compounds, Chromium Compounds, Naphthalene, Phenanthrene
Chemical Synonyms: Polycyclic Aromatic Hydrocarbons (PAHs)

2. Waste Material Source

Emergency flares are safety devices which provide for the flaring of gases vented from various process vessels. These flare systems are equipped with knock-out drums to limit the liquid hydrocarbon content. Sludges accumulating in these knock-out drums are periodically removed for disposal and/or recycling. These sludges could be found in batteries, gas plants, compression facilities and heavy oil processing plants.

3. Significant Components and Average Concentrations

Components	Average Concentration)	Range	
Inorganic Constituents			
Moisture	10.5%	3.3% to 26.1%	
Iron Total (Oxides, Sulphides)	24,200 mg/kg	1655 to 42,000 mg/kg	
Sulphides	14,000 mg/kg	No range found	
Aluminum	2150 mg/kg	1820 to 3680 mg/kg	
Trace Metals			
Arsenic	8.4 mg/kg	0.06 to 10.8 mg/kg	Note 5
Cadmium	<0.1 mg/kg	<0.1 mg/kg	Note 5
Chromium (Cr^{+6})	587.55 mg/kg	0.004 to 1290 mg/kg	Note 5
Lead	35.0 mg/kg	0.001 to 80.1 mg/kg	Note 5
Mercury	0.13 mg/kg	0.053 to 0.8504 mg/kg	Note 5
Nickel	13.5 mg/kg	0.05 to 50.0 mg/kg	Note 5
Thallium	No data available		
Selenium	No data available		

Waste Name: **Sludges - Flare Knock-Out (Cont'd)**

Id. Number: **31**

Organic Constituents

	Average Concentration	Range
Oil & Grease	0.65%	0.5% to 3.48%
Naphthalene	97 mg/kg	42 to 185 mg/kg
Phenanthrene	163 mg/kg	38 to 244 mg/kg
Total Extractable	1.93%	No range reported

Notes on Analytical Data:

Note 1: Only trace metals listed in the Alberta Hazardous Waste Regulations, and which may influence the disposal of this waste in a landfill, are reported.

Note 2: Available literature indicate that this waste will contain hydrocarbons, predominantly C10 to C20, mercaptans and a wide range of priority pollutants. No specific analytical data was found to confirm these constituents.

Note 3: Flare knock-out drain sludges are often disposed of in "burn pits." Therefore, inference was drawn from burn pit sludge analysis to confirm composition of this waste.

Note 4: Analytical data for PAH was found. Information regarding Pheno's or Base Neutral Groups is not available.

Note 5: Concentrations reported are those found in leachate extractions.

4. Analytical Methods

No information is available regarding the methodology used for the analysis of inorganic constituents.

Trace metal analyses were undertaken on leachate. Therefore, results reported are leachable metals only. The extraction procedure used is based on B.C. Ministry of Environment, Special Waste regulations (B.C. Reg. 63-88 OC. 268/88). This procedure is based on extraction at pH 5.0 using 0.5N acetic acid for 24 hours. The resulting liquid extract was analysed for trace metals using ICP and non-flame AA (for As, Cd, Pb and Mg).

PAH determinations were undertaken by GC/MS. According to US.EPA Method 625. No information regarding extraction/fractionation procedures is available.

5. Health Hazards and Safety Information

Toxicology (Significant Components):

Sulphides: Toxicity variable depending on specific compounds. In general;, they are similar to alkalies, may cause skin irritation.

Chromium (Cr^{+6}) Compounds: In general, chromic acid salts have a corrosive action on skin and on mucous membranes. Chromate salts have been associated with cancer of the lungs.

Waste Name: Sludges - Flare Knock-Out (Cont'd)

Id. Number: 31

Naphthalene/Phenanthrene: 15 minute Occupational Exposure Limit: 15 ppm. Suspected carcinogens.

Physical and Chemical Hazards:

Sulphides: Fire hazard: MOD. (Specific to compounds). Upon contact with acids H_2S is liberated. Strong oxidizing agents may react violently in contact with sulphides.

Chromium (CR^{+6}) Compounds: These compounds, in general, are oxidizing agents. May react violently with reducing agents. (May react with sulphides).

Naphthalene/Phenanthrene: Fire hazard: slight. Can react with oxidizing materials.

6. Indicated Waste Classification:

TDGR Number (if listed): Not listed

TDGR Classification (if listed) 9.3
9.2 (Possibly)

Hazardous Classifications:

British Columbia: Special Waste: X

Non-Special Waste:

Alberta: Hazardous: X

Non-hazardous:

Rationale for Classification: Average arsenic, chromium, lead and mercury concentrations in the leachate extractions exceed 5.0, 5.0, 5.0 and 0.1 mg/L respectively. As such, this waste meets the criteria of Class 9.3 under the TDGR and is, therefore, a hazardous waste in Alberta and a special waste in British Columbia.

In addition, based on average chromium concentrations, this waste could not be disposed of in a landfill in Alberta.

7. References

Analytical Data: 3
Toxicology:
Analytical Methodology: B.C. Ministry of Environment (Reg. 63/88 OC. 268/88)
Data Reliability: D

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CANADIAN PETROLEUM ASSOCIATION

WASTE INFORMATION SHEET

1. **Waste Material Identification:** **Id. Number:** 68

Waste Name: Sludge - Flare Pit **Date:** June 13, 1989
Synonyms: Burn Pits
Chemical Name of Major Components:
Chemical Synonyms:

2. **Waste Material Source:**

Flare pits or burn pits are used for the disposal of hydrocarbon containing waste materials with properties that make recycling unsuitable. Flare pits are used in conjunction with a gasoline plant, natural gas processing plant, pressure maintenance of a pressurizing plant, tank battery or a well. Sludges are accumulated in the bottom of these pits.

3. **Significant Components and Average Concentrations**

Components	Average Concentration	Range
Inorganic Constituents		
Ash Content	2.8%	0.5% to 3.7%
Iron Oxide (Total)	25.35%	11.8% to 26.5%
Iron Sulphide	3450 mg/kg	1250 to 5850 mg/kg
Total Sulphides	10,500 mg/kg	580 to 20,100 mg/kg
Cyanide	2.0 mg/kg	No range available
Trace Metals		
Arsenic	0.95 mg/kg	<0.01 to 10.5 mg/kg
Cadmium	0.4 mg/kg	<0.1 to 4.5 mg/kg
Chromium (Cr^{+6})	10.45 mg/kg	0.015 to 19.9 mg/kg
Lead	56.5 mg/kg	23 to 345 mg/kg
Mercury	0.47 mg/kg	0.05 to 1.85 mg/kg
Nickel	19.5 mg/kg	0.056 to 50.0 mg/kg
Thallium	No data available	
Selenium	No data available	
Organic Constituents		
	Average Concentration	**Range**
Oil & Grease	9.8%	5.75% to 26.1%
Total Hydrocarbons	10,500 mg/kg	9380 to 15,500 mg/kg
Mercaptans (Methyl to Butyl)	3.47 mg/kg	215 to 497 mg/kg
Phenols	5.5 mg/kg	1.8 to 7.8 mg/kg
Acetaphthene	22 mg/kg	No range reported
Fluorene	78 mg/kg	No range reported

Waste Name: Sludge - Flare Pit (Cont'd)

Id. Number: 68

Notes on Analytical Data:

Note 1: Only trace metals listed in the Alberta Hazardous Waste Regulations, and which may influence the disposal of this waste in a landfill, are reported.

Note 2: Approximately 80% of the total hydrocarbon content is C_{11} to C_{19}.

Note 3: The majority of the organics present in these wastes is not quantitated. Literature available indicate that the range of organics present include Ethyl/Methyl and Propyl Benzene and Naphthalenes.

4. Analytical Methods

Trace metal analysis were undertaken on a lechate prepared by using a 1:20 sample of extract dilution as specified in the US EPA leach protocol.

Two of the organic analysis were undertaken on samples extracted using US EPA Method 3540 "soxhlet extraction." These fractions were then analysed according to US EPA Method 8270 "SC/MS for Semivolatile Organics."

No specific information is available for the remaining 4 analysis.

QC/QA date regarding the verification of the extraction and sample clean-up procedures is reported.

The trace hydrocarbon scan would capture all organics and report it as hydrocarbons.

5. Health Hazards and Safety Information

Toxicology (Significant Components):

Mercaptans: In general, mercaptans have a very offensive odor, which may cause nausea and headache. Irritation effects: SEV. eye, oral, dermal, inhalation.

Lead: Lead poisoning is one of the most common occupational diseases. Irritation effects: High oral, inhalation. Some compounds are CAR. Mode of entry by inhalation, ingestion, dermal. (Organic Lead Compounds).

Physical and Chemical Hazards:

Lead: Fire and explosion hazard - slight.

Mercaptans: Dangerous when heated to decomposition. Mercaptans may emit highly toxic fumes of sulphur oxides which will react with water to produce corrosive conditions.

Waste Name: Sludge - Flare Pit (Cont'd)

Id. Number: 68

6. Indicated Waste Classification:

TDGR Number (if listed): NA 9500

TDGR Classification (if listed) 9.3 (Likely)

Hazardous Classifications:

British Columbia:	Special Waste:	X
	Non-Special Waste:	
Alberta:	Hazardous:	X
	Non-hazardous:	

Rationale for Classification:

Amended TDGR includes leachate concentrations (NA 9500). Classification 9.3 (Limit - 5 mg/l). The amended TDGR regulations effect Alberta Transportation regulations. In British Columbia the Special Waste legislation includes the leachable metals classification. According to these regulations this is a Hazardous or Special Waste.

Although leachate extraction test results were not found, it is likely that concentrations of lead in leachates extracted from this waste will exceed 5.0 mg/L. As such, this waste will likely meet the criteria of Class 9.3 under the TDGR and will, therefore, likely be a hazardous waste in Alberta and a non-hazardous waste in British Columbia.

7. References

Analytical Data:	7
Toxicology:	K. Veschaeren et al. Handbook of Environmental Data on Organic Chemicals (1983)
Analytical Methods:	U.S. EPA Analytical Protocol
Data Reliability:	A

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CANADIAN PETROLEUM ASSOCIATION

WASTE INFORMATION SHEET

1. Waste Material Identification: Id. Number: 73.76

Waste Name: Sludge - Sulphur Block Run-off Date: June 12, 1989
Synonyms: Acid Water Pond Sludge, Neutralization Sludge
Chemical Name of Major Components: Iron Oxide, Iron Sulphide, Sulphur, Oil & Grease
Chemical Synonyms: Ferrous Oxide, Ferrous Sulphide

2. Waste Material Source

Sulphur block runoff water is usually collected in dedicated gathering ponds on plant sites. The low pH water is then neutralized (usually with lime, however, at times ammonium hydroxide or sodium hydroxide may also be used). It is expected that all sour gas plants that have sulphur recovery facilities would have this waste.

3. Significant Components and Average Concentrations

Components	Average Concentration	Range
Inorganic Constituents		
Cyanide	21 mg/kg	2.5% to 4.8%
Aluminum	2.2%	1.6% to 4.0%
Manganese	2250 mg/kg	0.5 to 6000 mg/kg
Iron	1.5%	0.5% to 5.1%
Total Sulphur	2.4%	0.05% to 8.46%
Trace Metals		
Arsenic	4.7 mg/kg	3.6 to 6.0 mg/kg
Cadmium	0.33 mg/kg	0.25 to 0.8 mg/kg
Chromium (Cr^{+6})	71.5 mg/kg	42 to 130 mg/kg
Lead	14.0 mg/kg	2.5 to 17.0 mg/kg
Mercury	0.081 mg/kg	0.005 to 0.11 mg/kg
Nickel	8.3 mg/kg	7.6 to 11.4 mg/kg
Thallium	50.0 mg/kg	No range available
Selenium	No data available	

Waste Name: **Sludge - Sulphur Block Run-off** **Cont'd**

Id. Number: **73, 76**

Organic Constituents

	Average Concentration	Range
Oil & Grease	0.86%	0.81 to 0.89
Trichlorophenol	0.03	No range available
Pentachlorophenol	0.93	0.08 to 0.11
Total Phenols	3.45	<0.2 to 9.6

Notes on Analytical Data:

Note 1: Only trace metals listed in the Alberta Hazardous Waste Regulations, and which may influence the disposal of this waste in a landfill, are reported.

Note 2: The wide discrepancies in Manganese, Aluminum and iron concentrations, as indicated by the range reported, is due to pH variations. At higher pH values the precipitated amount of these metals is increased. Discrepancies in total sulphur values are not easily rationalized.

4. Analytical Methods

Surface run-off waters generally contain significant amounts of clay type materials. This will affect the acid extractable aluminum. However, this is not regarded as being of environmental significance.

All metals were determined on nitric/perchloric acid digests by plasma emission spectroscopy (ICAN). Atomic absorption analysis were used as a back-up procedure (except for mercury and lead which were analysed by AA).

No information was found regarding the identification of organics.

Oil and grease analysis were carried out using solvent extraction with lexane/acetone followed by filtration through sodium sulphate to remove water and the residue on evaporation of solvents was determined gravimetrically.

5. Health Hazards and Safety Information

Toxicology (Significant Components):

Sulphur Compounds (including Sulphates, Sulphides, Sulphites):

Sulphur has a low toxicity. Toxicity of other sulphur contain radicals of variable depending on the specific compounds. Alkaline sulphides are similar to other alkalies. Hydrogen sulphide may be liberated which is highly toxic. Sulphites have generally MOD toxicity since they rapidly oxidize to sulphates.

Iron: While not specifically identified it is expected that Iron Oxide and Iron Sulphide could be present in this waste. Iron sulphide may liberate toxic hydrogen sulphide gas when in contact with acids.

Waste Name: Sludge - Sulphur Block Run-off **Cont'd**

Id. Number: 73, 76

Physical and Chemical Hazards:

Sulphur Compounds: MOD fire hazard when exposed to flame or by spontaneous chemical reaction. Some sulphides are strong reducing agent, may react with oxidizers violently. Hydrogen sulphide evolved can form explosive mixtures with air. Sulphides are dangerous when heated to decomposition. They may emit toxic fumes of oxides of sulphur and H_2S. Sulphites when heated to decomposition, may emit toxic and corrosive sulphur dioxide.

6. Indicated Waste Classification:

TDGR Number (if listed):

TDGR Classification (if listed): 9.3 (Possibly)

Hazardous Classifications:

British Columbia: Special Waste:

Non-Special Waste: X

Alberta: Hazardous:

Non-hazardous: X

Rationale for Classification: Based on the analytical data found, this waste does not appear to contain TDGR Listed Components in sufficient concentrations to warrant hazardous/special classification.

The waste could potentially generate leachates containing chromium concentrations in excess of 5.0 mg/L and hence, could be classified under Class 9.3 of the TDGR. However, this would likely occur only in the upper range of chromium concentrations. As such, it is felt that this waste will be non-hazardous/non-special in the majority of cases.

7. References

Analytical Data: 5

Toxicology: Sax, Sixth Edition

Analytical Methodology: CPA Task Force: Run-off Water Sulphur Storage Areas (1980)

J. Ashworth: The Inorganic Characteristics of Sludges Associated with Natural Gas Processing (1986)

Data Reliability: C

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CANADIAN PETROLEUM ASSOCIATION

WASTE INFORMATION SHEET

1. **Waste Material Identification:** Id. Number: 74

Waste Name: Sludge - Process Pond Date: June 12, 1989
Synonyms: Evaporation Pond, Wastewater Pond
Chemical Name of Major Components: Xylene, Iron Sulphides, Aluminum Oxide/Sulphate
Chemical Synonyms: M, O & P Xylene (Xylol)

2. **Waste Material Source**

Liquid wastes are normally disposed of via plant sump systems where wash waters, lubricating oils, filter backwash and blowdown waters are collected. In some plants, surface drainage and utility blowdown waters are also discharged into a central pond. These ponds are found predominantly in gas processing plants but can also be present in conventional and heavy crude oil production facilities.

3. **Significant Components and Average Concentrations**

Components	Average Concentration	Range
Inorganic Constituents		
Solids	31.5%	21.05% to 38.65%
Water	59.5%	43.0% to 68.0%
Sulphides	2655.5 mg/kg	180 to 11,650 mg/kg
Chlorides	6500 mg/kg	5050 to 7460 mg/kg
Aluminum	15,500 mg/kg	No range available
Cyanides	0.17 mg/kg	0.11 to 0.29 mg/kg
Trace Metals		
Arsenic	0.15 mg/kg	0.01 to 3.9 mg/kg
Cadmium	4.3 mg/kg	0.01 to 14.1 mg/kg
Chromium (Cr^{+6})	1056 mg/kg	72.5 to 4,330 mg/kg
Lead	5.5 mg/kg	0.15 to 14.5 mg/kg
Mercury	0.315 mg/kg	0.212 to 1.4 mg/kg
Nickel	26.5 mg/kg	14.5 to 49.0 mg/kg
Thallium	1.60 mg/kg	<0.05 to 2.08 mg/kg
Selenium	No data available	

Waste Name: **Sludge - Process Pond (Cont'd)**

Id. Number: **74**

Organic Constituents

	Average Concentration	Range
BTEX (Total Volatile)	340 mg/kg	No range found
PAHs (Total)	14,500 mg/kg	12,800 to 15,500 mg/kg
Paraffins/Olefins	1.15%	0.85% to 1.9%
Organosulphur Compounds	20.2 mg/kg	No range found
Phenols	0.2 mg/kg	0.15 to 0.80 mg/kg
Total Hydrocarbons	2.35%	2.01% to 3.05%
Oil and Grease	3.65 mg/kg	3.5 to 4.55 mg/kg

Notes on Analytical Data:

Note 1: Only trace metals listed in the Alberta Hazardous Waste Regulations, and which may influence the disposal of this waste in a landfill, are reported.

Note 2: It is expected that Cr^{+6} values reported above would be reduced to Cr^{+3} in systems where high levels of sulphides are present.

Note 3: Only limited analytical data was found for BTEX (Xylene is the major component). Other analytical work on similar wastes from different locations failed to confirm the relatively high volatiles value.

Note 4: Analytical results show that the organic components of these sludges are generally consistent from plant to plant. With a few exceptions, specifically in the sulphide and Cr^{+6} ranges, the compounds identified and the ranges are similar. It is to be noted that most of the analytical data is from sour gas plant process ponds.

4. Analytical Methods

Trace metals analysis were carried out on acid digested samples by Inductively Coupled Argon Plasma spectrometer (ICAP). The wet ash method is also acceptable. Mercury and lead analysis were carried out by flameless Atomic Absorption (AA) method.

Oil and grease content were determined by gravitimetric methods on freon extracted samples according to EPA Method 413.1. IR Relative Absorbance method, (EPA Method 413.2) measured at 454 nm is also used. These results should be used with caution since the method is specific for certain chromophones and may give low results.

Hexavalent chromium in the high range: samples were analysed colorimetrically on the acid and water fractions by reaction with diphenyl carbazide in acid solution.

A number of organic extraction methods was reported for GC/MS characterization. The soxhlet extraction method using acetone/hexane/acetic acid was used in most cases. Aromatic and polar compounds were determined after elution with benzene and methylene chloride respectively on an alumina column.

Waste Name: Sludge - Process Pond (Cont'd)

Id. Number: 74

5. Health Hazards and Safety Information

Toxicology (Significant Components):

Sulphides: Toxicity variable depending on specific compounds. In general;, they are similar to alkalies, may cause skin irritation. MOD/SEV via oral, liberating free H_2S and alkalie compounds.

Chromium (CR^{+6}) Compounds: Irritation effects: SEV. eye, oral, dermal. In general, chromic acid salts have a corrosive action on skin and on mucous membranes. Chromate salts have been associated with cancer of the lungs.

Polyaromatic Hydrocarbons (PAH): These compounds (including Naphthalenes and Phenonthrene) are generally toxic and possibly carcinogens. Irritation effects: SEV. eye, oral. MOD via dermal.

Xylene: Irritation effects: MOD eye, dermal, inhalation, oral.

Physical and Chemical Hazards:

Sulphides: Fire hazard: MOD. (Specific to compounds). Upon contact with acids H_2S is liberated. Strong oxidizing agents may react violently in contact with sulphides.

Chromium (CR^{+6}) Compounds: These compounds, in general, are oxidizing agents. May react violently with reducing agents. (May react with sulphides).

PolyAromatic Hydrocarbons: Fire Hazard, MOD when exposed to heat or flame. These compounds can react with oxidizing materials. Explosion hazard: MOD.

Xylene: Fire Hazard. Dangerous when exposed to heat or flame, can react with oxidizing materials. Explosion Hazard: MOD in form of vapor (Range 1.1% to 7.0% in air).

6. Indicated Waste Classification

TDGR Number (if listed):

TDGR Classification (if listed): 9.3 (Likely)
9.2 (Possibly)

Hazardous Classifications:

British Columbia:	Special Waste:	X
	Non-Special Waste:	
Alberta:	Hazardous:	X
	Non-hazardous:	

Waste Name: Sludge - Process Pond (Cont'd)

Id. Number: 74

Rationale for Classification:	Although leachate extraction tests were not found, it is likely that concentrations of chromium in leachates extracted from this waste will exceed 5.0 mg/L. As such, the waste will likely meet the criteria of Class 9.3 of the TDGR and will, therefore, most likely be a hazardous waste in Alberta and a non-hazardous waste in British Columbia. In addition, since a number of chromium compounds are listed under Class 9.2 in the TDGR, it is conceivable that the waste could be classified hazardous/special if these compounds are present at concentrations exceeding 100 mg/kg. It should also be noted that based on average chromium concentrations, this waste could be disposed of in a landfill in Alberta.

7. References

Analytical Data:	8
Toxicology:	Sax, Sixth Edition
Analytical Methods:	J.V. Headley, Chemex Labs (1988) J. Ashworth, Norwest Labs (1986) CPA Report (1986)
Data Reliability:	A

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CANADIAN PETROLEUM ASSOCIATION

WASTE INFORMATION SHEET

1. **Waste Material Identification:** Id. Number: 77

Waste Name: Sludge - Treater Bottom Date: June 13, 1989
Synonyms:
Chemical Name of Major Components: Asphaltine, Sodium Chloride, Iron Oxides
Chemical Synonyms: Bitumen, Petroleum Pitch

2. **Waste Material Source**

Treaters are used in conventional and heavy oil production facilities for the separation of oil, water and natural gas.

3. **Significant Components and Average Concentrations**

Components	Average Concentration	Range
Inorganic Constituents		
Solids	65.3%	25.5% to 78.0%
Sodium Chloride	58.5%	11.3% to 66.5%
Iron Oxides	3.5%	1.35% to 11.0%
Calcium Carbonate	1.5%	0.5% to 31.0%
Water	10.8	8.5% to 18.0%
Trace Metals		
Arsenic	3.5 mg/kg	<0.0025 to 9.3 mg/kg
Cadmium	<0.1 mg/kg	<0.1 mg/kg
Chromium (Cr^{+6})	145 mg/kg	80.5 to 198 mg/kg
Lead	248 mg/kg	140 to 1200 mg/kg
Mercury	<0.01 mg/kg	<0.01 mg/kg
Nickel	1.6 mg/kg	0.1 to 14.0 mg/kg
Thallium	No available data	
Selenium	No available data	
Organic Constituents		
Organics & Volatile	28.5%	4.65% to 50.5%
Oil & Grease	25.5%	10.3% to 63.9%
Asphaltine	5.1%	3.0% to 16.1%

Waste Name: Sludge - Treater Bottom (Cont'd)

Id. Number: 77

Notes on Analytical Data:

Note 1: Only trace metals listed in the Alberta Hazardous Waste Regulations, and which may influence the disposal of this waste in a landfill, are reported.

Note 2: "Organics and volatiles" are identified as mainly pyrobitumin.

Note 3: Other organics identified but not quantified are styrenes and phenols.

4. Analytical Methods

The inorganic results are reported on "as received" sample basis.

Trace metal analysis were carried out on acid digested samples by Inductively Coupled Argon Plasma Spectrometer (ICAP). No specific information is available regarding the method used for Hg or Pb analysis.

Oil and grease analysis were carried out by gravimetric methods on crushed and benzene extracted samples. (No US EPA reference is available for benzene extraction).

No identification of oil phase or water soluble organics in water phase is available.

5. Health Hazards and Safety Information

Toxicology (Significant Components):

Lead: Lead poisoning is one of the most common occupational diseases. Irritation effects: High oral, inhalation. Some compounds are CAR. Mode of entry by inhalation, ingestion, dermal. (Organic Lead Compounds).

Chromium (CR^{+6}) Compounds: Irritation effects: SEV. eye, oral, dermal. In general, chromic acid salts have a corrosive action on skin and on mucous membranes. Chromate salts have been associated with cancer of the lungs.

Asphaltine: Irritation effects: MOD via oral, inhalation. Slight via dermal.

Physical and Chemical Hazards:

Lead: Fire and explosion hazard - slight.

Chromium (Cr^{+6}) Compounds: These compounds, in general, are oxidizing agents. May react violently with reducing agents. (May react with sulphides).

Asphaltine: Fire Hazard: Slight when exposed to heat or flame.

Waste Name: Sludge - Treater Bottom (Cont'd)

Id. Number: 77

6. Indicated Waste Classification:

TDGR Number (if listed): NA 9500

TDGR Classification (if listed) 9.3 (Likely)

Hazardous Classifications:

British Columbia:	Special Waste:	X
	Non-Special Waste:	
Alberta:	Hazardous:	X
	Non-hazardous:	

Rationale for Classification: Although leachate extraction test results were not found, it is likely that concentrations of lead and chromium in leachates extracted from this waste will exceed 5.0 mg/L. As such, the waste will likely meet the criteria of Class 9.3 under the TDGR and will, therefore, be a hazardous waste in Alberta and a special waste in British Columbia.

In addition, since a number of lead and chromium compounds are listed under Class 9.2 in the TDGR, it is conceivable that the waste could be classified hazardous/special if these compounds are present at concentrations exceeding 100 mg/kg.

7. References

Analytical Data:	5
Toxicology:	Sax, Sixth Edition
Analytical Methods:	
Data Reliability:	B

The information contained in this document is believed to be reliable as of the date of issue, but such information is nonetheless of a general nature. The user or those in contact with this waste must utilize the information supplied to develop appropriate safe work and handling practices. All statements and suggestions are made without warranty, express or implied, regarding the completeness or accuracy of the information, the hazards connected with the waste material itself or the results obtained from the handling, transportation or disposal of the material. In addition, the CPA and its consultant must rely upon the persons handling the waste material to exercise care and precautions integral to hazardous waste transportation/ disposal operations.

CANADIAN PETROLEUM ASSOCIATION

WASTE INFORMATION SHEET

1. Waste Material Identification: Id. Number: 83

Waste Name: Well Workover Fluids - Acid Date: June 12, 1989
Synonyms:
Chemical Name of Major Components:
Chemical Synonyms:

2. Waste Material Source

Acids used for well stimulations can be found in the following two forms as a waste product:

i) Residual acids not used during the well workover. These will be found in storage tanks or barrels at the well site.

ii) Acids produced in conjunction with hydrocarbons during the first stages of production following the well workover.

3. Significant Components and Average Concentrations

Components	Average Concentration	Range
Inorganic Constituents		
Hydrochloric Acid	Not reported	0% to 60%
Hydrofluoric Acid	Not reported	0% to 10%
Sulphuric Acid	Not reported	0% to 60%
Trace Metals		
Arsenic	3.5 mg/kg	<0.0025 to 9.3 mg/kg
Cadmium	<0.1 mg/kg	<0.1 mg/kg
Chromium (Cr^{+6})	145 mg/kg	80.5 to 198 mg/kg
Lead	248 mg/kg	140 to 1200 mg/kg
Mercury	<0.01 mg/kg	<0.01 mg/kg
Nickel	1.6 mg/kg	0.1 to 14.0 mg/kg
Thallium	No data available	
Selenium	No data available	
Organic Constituents		
Ethyleneadiaminetetraacetic acid (EDTA)	Not reported	0 to 100 mg/kg

Notes on Analytical Data:

Note 1: Numerous chemicals are added to the above acids to act as biocides, inhibitors, retarders and surfactants. While the amount of chemical added is job specific, in most cases the chemical is added to create a concentration of 0.5 to 2.0% in solution.

Waste Name: **Well Workover Fluids - Acid (Cont'd)**

Id. Number: **83**

4. Analytical Methods

Not reported.

5. Health Hazards and Safety Information

Toxicology (Significant Components):

Hydrochloric Acid: Irritation effects: SEV. eye, skin, oral.

Hydrofluoric Acid: Irritation effects: SEV eye, respiratory system, skin, oral.

Sulphuric Acid: Irritation effects: No information found.

Physical and Chemical Hazards:

Hydrochloric, Hydrofluoric and Sulphuric Acids:
Violent chemical reaction when mixed with alkalies (e.g. ammonia, hydroxides, cyanides, sulphides, hypochlorites, chlorites). Will generate heat with splattering and boiling and the release of toxic fumes.

EDTA: Violent chemical reactions when mixed with strong oxidizers (e.g. chlorine, peroxides, chromates, nitric acid, perchlorates, concentrated oxygen, permanganates). Will generate heat, fires, explosions and/or the release of toxic fumes.

6. Indicated Waste Classification:

TDGR Number:
EDTA - 9117 (Item No. 1311)
HCl - 1789 (Item No. 1559)
HF - 1790 (Item No. 1563)
H_2SO_4 - 1830 (Item No.s 2730, 2731)

TDGR Classification (if listed):
6.1 (Poisonous/Toxic) - HF
8 (Corrosive) - HCl, HF, H_2SO_4
9.2 (Miscellaneous - Environmentally Hazardous) - HCl, HF, H_2SO_4, EDTA

Waste Name: **Well Workover Fluids - Acid (Cont'd)**

Id. Number: 83

Hazardous Classifications:

British Columbia:	Special Waste:	X
	Non-Special Waste:	
Alberta:	Hazardous:	X
	Non-hazardous:	

Rationale for Classification: All acids are listed in the TDGR as either Class 6.1, 8 or 9.2 dangerous goods. Therefore, residual acids from well workovers will be classified hazardous in Alberta and special in British Columbia.

All workover fluids produced in conjunction with hydrocarbons may or may not be hazardous depending upon the concentration of acid in the fluid stream. This is dependent upon the flow rate of the produced stream and the nature of the formation being acidized (e.g. acids will be neutralized in a carbonate formation).

7. References

Analytical Data:	0
Toxicology:	Sax, Sixth Edition, Halliburton Services, Material Safety Data (1988)
Analytical Methods:	
Data Availability:	E

The information contained in this document is believed to be reliable as of the date of issue, but such information is nonetheless of a general nature. The user or those in contact with this waste must utilize the information supplied to develop appropriate safe work and handling practices. All statements and suggestions are made without warranty, express or implied, regarding the completeness or accuracy of the information, the hazards connected with the waste material itself or the results obtained from the handling, transportation or disposal of the material. In addition, the CPA and its consultant must rely upon the persons handling the waste material to exercise care and precautions integral to hazardous waste transportation/ disposal operations.

CANADIAN PETROLEUM ASSOCIATION

WASTE INFORMATION SHEET

1. Waste Material Identification: Id. Number: 84

Waste Name: Well Workover Fluids - Hydrocarbons Date: June 8, 1989.
Synonyms: Frac Fluids
Chemical Name of Major Components:
Chemical Synonyms:

2. Waste Material Source:

This waste is produced during fracturing and solvent squeezing well stimulation programs. Wastes generated can be either the unused fluid contained in the bottom of tanks/barrels or the fluid produced during the initial stages of production following the stimulation.

3. Significant Components and Average Concentrations

Components	Average Concentration	Range
Inorganic Constituents		
Hydrochloric Acid	Not reported	0 to 15%
Acetic Acid	Not reported	0 to 10%
Formic Acid	Not reported	0 to 10%
Trace Metals		
Arsenic	Not reported	Not reported
Cadmium	Not reported	Not reported
Chromium (Cr^{+6})	Not reported	Not reported
Lead	Not reported	Not reported
Mercury	Not reported	Not reported
Nickel	Not reported	Not reported
Thallium	Not reported	Not reported
Organic Constituents		
Diesel Fuel	Not reported	0 to 60%
Kerosene	Not reported	0 to 60%
Crude Oil	Not reported	0 to 60%
Distillate	Not reported	0 to 60%
Methanol	Not reported	0 to 85%
Toluene	Not reported	0 to 100%
Xylene	Not reported	0 to 100%

Waste Name: **Well Workover Fluids - Hydrocarbons Cont'd**

Id. Number: **84**

Notes on Analytical Data:

Note 1: Analyses based on suppliers publications and Material Safety Data Sheets. Therefore, they are applicable only to residual fluids not used during well workovers.

Note 2: Numerous chemicals are added to the above components to act as gelling agents, surfactants, clay stabilizers, fluid control agents and fluid friction reducing agents. The amount and type of chemical used is job specific.

4. Analytical Methods

Not Reported.

5. Health Hazards and Safety Information

Toxicology (Significant Components):

Hydrochloric Acid: Irritation effects: SEV. eye, respiratory system, skin, oral.

Acetic Acid: Toxic Hazard rating SEV via oral, eye. MOD/SEV via inhalation, dermal. Can cause skin burns. Inhalation causes irritation of mucous membranes.

Formic Acid: Irritation effects: MLD - skin, SEV eyes, upper respiratory system.

Diesel Fuel: Suspected carcinogen.

Kerosene: Carcinogen.

Crude Oil: Toxic Hazard rating Slight/MOD via inhalation, dermal, MOD eye, oral.

Distillates (Aliphatic Hydrocarbons Mixture): Toxic Hazard rating slight via oral, eye, dermal. MOD via inhalation.

Methanol: Irritation effects: MOD/SEV via oral, inhalation. Slight/MOD eye, slight dermal.

Toluene: Irritation effects: MOD via eye, dermal. SEV via oral, inhalation.

Xylene: Irritation effects: slight/MOD Via eye, oral, dermal, inhalation.

Physical and Chemical Hazards:

Hydrochloric Acid: Violent chemical reactions when mixed with alkalies (e.g. ammonia, hydroxides, cyanides, sulphides, hypochlorites, chlorites). Will generate heat with spattering and boiling, fires, explosions and/or the release of toxic fumes.

Formic Acid: Violent chemical reactions when mixed with alkalies (e.g. ammonia, hydroxides, cyanides, sulphides, hypochlorites, chlorites). Will generate heat with spattering and boiling, fires, explosions and/or the release of toxic fumes.

	Violent chemical reactions when mixed with strong oxidizing (e.g. chlorine, peroxides, chromates, nitric acid, perchlorates, concentrated oxygen, permanganates). Will generate heat, fires, explosions and the release of toxic fumes.
Acetic Acid:	Fire Hazard: MOD when exposed to heat or flame. Can react with oxidizing materials vigorously. Particularly dangerous in contact with chromic acid, peroxides and nitric acid. Explosion Hazard: MOD.
Diesel Fuel:	Violent chemical reactions when mixed with strong oxidizing (e.g. chlorine, peroxides, chromates, nitric acid, perchlorates, concentrated oxygen, permanganates). Will generate heat, fires, explosions and the release of toxic fumes.
Kerosene:	Violent chemical reactions when mixed with strong oxidizing (e.g. chlorine, peroxides, chromates, nitric acid, perchlorates, concentrated oxygen, permanganates). Will generate heat, fires, explosions and the release of toxic fumes.
Crude Oil:	Fire Hazard: MOD when exposed to heat or flame. Can emit toxic fumes if reacts with oxidizing materials. Explosion Hazard: slight.
Distillate:	Dangerous when exposed to heat or flame. Can react with oxidizing agents vigorously. Explosion Hazard: MOD (range 1.1 to 5.5% in air).
Methanol:	Violent chemical reactions when mixed with strong oxidizing (e.g. chlorine, peroxides, chromates, nitric acid, perchlorates, concentrated oxygen, permanganates). Will generate heat, fires, explosions and the release of toxic fumes. Contact with aluminum or zinc may produce flammable hydrogen gas.
Toluene:	Violent chemical reactions when mixed with strong oxidizing (e.g. chlorine, peroxides, chromates, nitric acid, perchlorates, concentrated oxygen, permanganates). Will generate heat, fires, explosions and the release of toxic fumes.
Xylene:	Violent chemical reactions when mixed with strong oxidizing (e.g. chlorine, peroxides, chromates, nitric acid, perchlorates, concentrated oxygen, permanganates). Will generate heat, fires, explosions and the release of toxic fumes.

6. <u>Indicated Waste Classification:</u>

TDGR Number:

HCl - 1789 (Item No. 1559)
Acetic Acid - 2789 (Item No. 7)
Formic Acid - 1779 (Item No. 1445)

Kerosene - 1223 (Item Nos. 1678, 1679)
Toluene - 1294 (Item No. 2831)
Xylene - 1307 (Item Nos. 3079, 3080, 3081)

TDGR Classification (if listed):

3.2 (Flammable - Div. 1) - Toluene, Xylene
3.3 (Flammable - Div. 2) - Kerosene, Xylene
6.1 (Poisonous/Toxic) - Xylene
8 (Corrosive) - Acetic Acid, Formic Acid, HCl
9.2 (Miscellaneous - Environmentally Hazardous) - HCl, Acetic Acid, Formic Acid, Toluene, Xylene

Hazardous Classifications:

British Columbia:	Special Waste:	X
	Non-Special Waste:	
Alberta:	Hazardous:	X
	Non-hazardous:	

Rationale for Classification:

All significant components listed with the exception of crude oil and methanol, are listed in the TDGR. In addition, chemicals added during the fracturing and solvent squeezing operations may also be listed under the TDGR. Therefore, in most cases, it is likely that residual workover fluids would be classified hazardous in Alberta and special in British Columbia.

Well workover fluids produced in conjunction with hydrocarbons following the well workover, may or may not be hazardous, depending upon the concentration of the significant components in the fluid stream. This will be dependent upon the flow rate of the produced stream and the composition of the workover fluid used.

7. References

Analytical Data: 0
Toxicology: Sax, Sixth Edition
Halliburton Services, Material Safety Data, 1988

Analytical Methodology:
Data Reliability: E

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SECTION 3.0

PETROLEUM INDUSTRY WASTE PROJECTS

3.0 PETROLEUM INDUSTRY WASTE PROJECTS

Petroleum waste management is a topic which is currently under considerable review throughout the industry. Numerous research projects are being conducted both privately and through government sponsorship. The following list represents projects which have been recently completed, currently underway or continuing with subsequent phases. Project publications completed within the last year are listed in Section 4.0, References.

1.0 Title: Treatment Alternative Evaluation for Sludges & Contaminated Soils
Sponsor: CPA, Environment Canada
Author: CH2M Hill Engineering Limited
Completion Date: Phase I - Fall 1989
Description: Phase I involves a review of the chemical characteristics of petroleum waste sludges and contaminated soil, in conjunction with an evaluation of treatment alternatives for these wastes. Phase II will involve pilot plant studies using the identifed treatment processes.

2.0 Title: Amine Process Sludges - Options for Treatment
Sponsor: CPA, ERCB, Env. Canada, Husky, Gulf
Author: C. Boyle, University of Calgary
Completion Date: January 1990
Description: An evaluation of the various options for disposal of amine sludges on both technical and economic bases. Options include landfarming, deep well injection and incineration. Includes amine sludge characterization and the preparation of analytical protocols for gas plant sludges.

3.0 Title: Gas Plant Sludge Characterization Study (Phases IIa & IIb)
Sponsor: CPA, Env. Canada, Alberta Research Council
Author: Western Research
Completion Date: December 1989. (Publication Phases IIa & IIb)
Description: Develop screening methods for characterizing sludges. Phase IIa- identification of heavy metals. Phase IIb- identification of organics and toxicity. Phase III-recommended sampling, handling and laboratory protocol. (1990)

4.0 Title: Evaluation of New Technologies for the Clean-up of Produced Sands from Heavy Oil Operations
Sponsor: CPA, Environment Canada, Sask-Alta Waste Co-op, AOSTRA.
Author: Not confirmed.
Completion Date: 3 year study, final completion 1991.
Description: Field work 1990.

5.0 Title: Land Treatment of Diesel Invert Drilling Muds
Sponsor: CPA, Environment Canada
Author: Norwest Soils
Completion Date: June 1989
Description: Three year field program. Various concentrations of mud are applied to soil to evaluate land treatment capability. Two conference papers have been previously prepared.

6.0 Title: Oily Waste Land Treatment, Environmental Considerations
Sponsor: CPA, Environment Canada
Author: Kananaskis Centre, University of Calgary
Completion Date: March 1990
Description: A 9 year study examining reclamation, plant uptake and ground water studies.

7.0 Title: Fate and Effects of Contaminants in Oily Waste when Applied to Soil
Sponsor: Environment Canada
Author: Environment Canada Wastewater Technology Centre
Completion Date: March 1991

8.0 Title: Utilization of Heavy Oil Wastes to Improve the Quality of Agriculturally Marginal Sandy Soils
Sponsor: Agriculture Canada, Environment Canada
Author: Agriculture Canada
Completion Date: March 1991

9.0 Title: Technical and Economic Assessment of Treatment and Disposal for Waste Sludges and Solids Produced by the Natural Gas Processing Industry
Sponsor: Environment Canada
Author: Environment Canada, Shell Canada Resources
Completion Date: March 1990
Description:

10.0 Title: Characterization of Drilling Wastes
Sponsor: Alberta Environment, Alberta Research Council
Author: Alberta Research Council
Completion Date: Fall, 1989
Description: Characterization of drilling muds from the Cold Lake, Foothills and Grande Prairie areas. Greenhouse studies of effects on vegetation.

11.0 Title: Land Treatment of Lime Sludges
Sponsor: Suncor Inc Resources Group
Author: Alberta Research Council
Completion Date: July 1989
Description: Characterization and sampling techniques.

12.0 Title: Land Spreading of Drilling Wastes
Sponsor: Esso Resources
Author: Alberta Research Council
Completion Date: 1991
Description: NaCl, KCl and freshwater drilling muds.

13.0 Title: Incineration on Fast Circulating Fluidized Beds
Sponsor: Canadian Waste Management Ltd., Vancouver
Author: Canadian Waste Management Ltd., Vancouver
Completion Date: 1990
Description: Sponsorship of Austrian designed incinerator for sample demonstration of petroleum industry wastes.

14.0 Title: Effect of Drilling Wastes on Crops and Soils
Sponsor: Saskatchewan Research Council, Saskatchewan Energy & Mines
Author: Saskatchewan Research Council, University of Saskatchewan Soil Testing Laboratory
Completion Date: Phases I & II complete, Phase III proposed.
Description: Freshwater fluids only. Phase I- volume estimations and proportions, potential effects. Phase II- soil applications in controlled environment to analyse changes in soil chemistry, plant growth, yield and heavy metal content. Phase III- field application to various soils and regions to also analyse changes in soil chemistry, plant growth, yield and heavy metal content.

15.0 Title: Use of Coal Agglomeration for the Cleanup of Oil Contaminated Soils and Wastes
Sponsor: Alberta Research Council, Alberta Environment
Author: Alberta Research Council
Completion Date: 1990
Description: Assessment of environmental conditions for using coal fines in oily waste. Agglomeration separates waste into solids, clean water and oil-coal.

16.0 Title: Analysis of Gas Plant Filters for Toxic Organic Chemicals
Sponsor: Newalta Environmental Services Corp.
Author: Enviro-Test Laboratories
Completion Date: March 1989
Description: Organic characteristics and leachate analysis of filters.

17.0 Title: Filter Pyrolysis Tests
Sponsor: Newalta Environmental Services Corp.
Author: Umatac Industrial Processes
Completion Date: May 1989
Description: Pyrolysis test results of gas plant filters and invert drilling muds.

18.0 Title: Incineration of Gas Plant Filters, Pilot Study
Sponsor: Newalta Environmental Services Corp.
Author: Newalta Environmental Services Corp.
Completion Date: Ongoing
Description: Test incineration burns with various gas plant and produced water filters.

19.0 Title: Filter Analysis
Sponsor: Amoco Canada Petroleum
Author: Chemex Labs, Chemical and Geological Laboratories, Enviro-Test Laboratories.
Completion Date: December 1989
Description: Provide agreement on analytical protocol and filter analysis.

20.0 Title: Characterization Study of Associated Wastes
Sponsor: American Petroleum Insitute - Production Waste Issue Group
Author: Exxon Production Research (Task Force Chairman)

Completion Date: December 1989
Description: Analysis of 50 to 100 petroleum wastes samples received from U.S. companies. Includes produced sand, tank bottoms, drilling muds and waste oils.

21.0 Title: Analytical Protocol Review
Sponsor: U.S. EPA, API
Author: Radian Corporation, Austin, Texas.
Completion Date: January 1990
Description: Analytical protocol review for the identification and characterization of organic components in oil field production wastes.

22.0 Title: International Symposium on Oil Field Wastes
Sponsor: American Petroleum Institute, U.S. Environmental Protection Agency
Conference Date: 1990, TBA

23.0 Title: Waste Management Conference
Sponsor: Air Pollution and Waste Management Control Association
Conference Date: Fall 1989

SECTION 4.0

REFERENCES

4.0 REFERENCES

This reference section contains two listings of published references. The lists do not include unpublished correspondence, analysis or comments between or within CPA member companies and/or their contractors.

List A: References 1 to 71 - were directly used in the preparation of this report.

List B: References 72 to 100 were obtained but not used in the preparation of this report. This list provides a valuable information source on petroleum industry wastes.

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35. "Analytical Report - GC/MS Characterization of Two Gas Plant Waste Sludges." Enviro-Test Laboratories, 1985.

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